INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer
FOR MANAGEMENT

MAY 1958
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FOR 1958 OVER 1957

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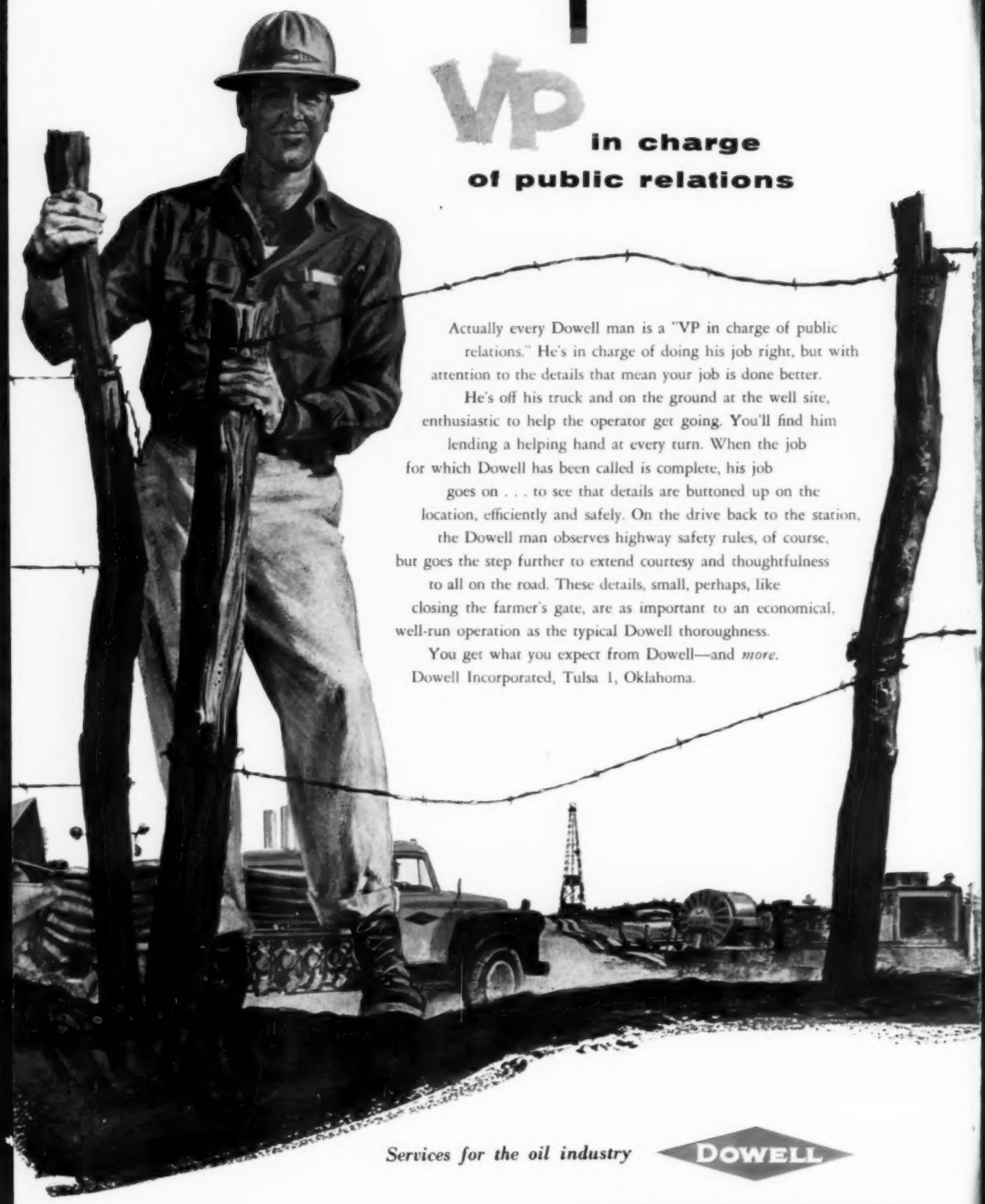
12th Annual Report Survey



VP in charge of public relations

Actually every Dowell man is a "VP in charge of public relations." He's in charge of doing his job right, but with attention to the details that mean your job is done better.

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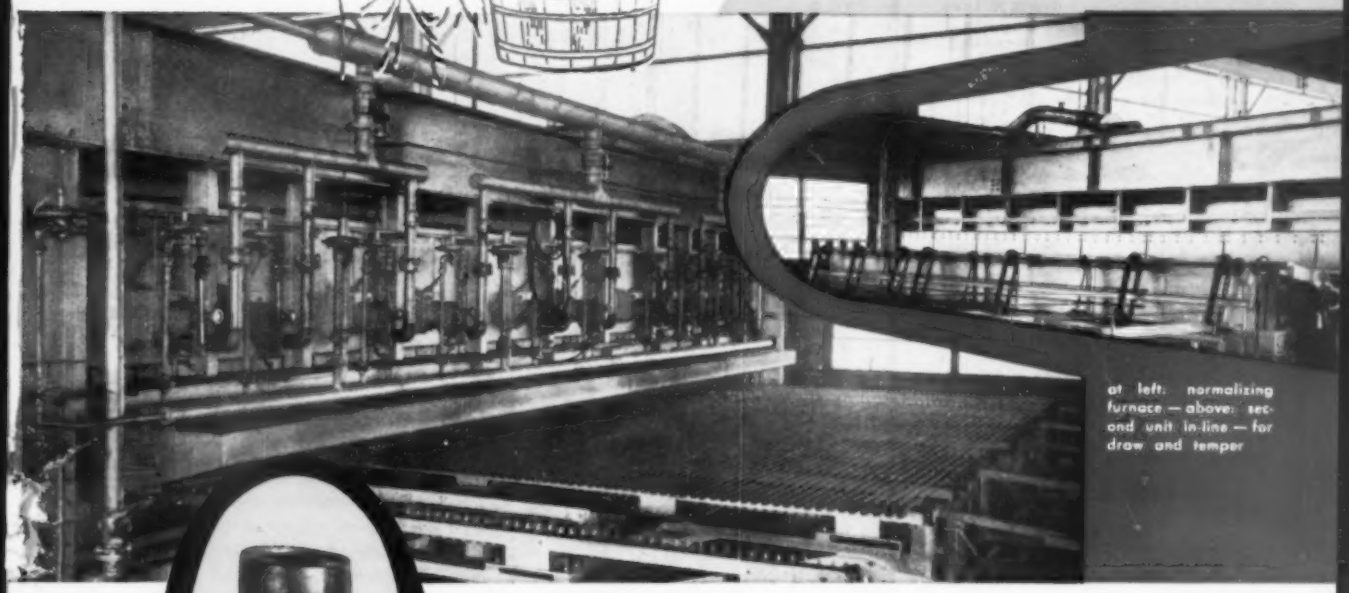

at left: normalizing furnace — above: second unit in-line — for draw and temper

Unretouched photograph of rod end before heat-treat. Note clean smooth forging by electric-induction process, unique with Norris.

. . . in LARGEST, MOST MODERN SUCKER ROD PLANT in the Oil Industry!

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Editor, Gulf Coast, JAckson 6-2631
2370 Rice Blvd., Room 110, Houston, Texas
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The Conference Table **A-10**
We have given you a republic, if you can keep it.
— Benjamin Franklin

1957 Topples All Records **A-17**
12th Annual Report Survey. *— Ernestine Adams*

Production Reaches New High A-21
Companies Surveyed Have High Percentage Wildcat Success.

Refiners Plan for Asphalt Market A-24
New Capacity Ready for Highway Program.

Transportation Improved A-25
Economies Achieved by New Pipelines.

E SECTION FOLLOWS A

How To Reduce Costs **E-1**
Key factors and basic rules for a successful cost reduction program . . . Check list for setting up organization and keeping it on the move. *— Benjamin P. Hamilton, Jr.*

Soviet 1958 Plans for Oil and Gas **E-5**

Course Focuses on Controls **E-6**
Executive development program organized around one theme — controls. These include reports, budgets, plans of wide application. *— W. T. Jerome III*

Secrets May Be a Stumbling Block **E-8**
Almost total disclosure is the policy of many successful companies. Here's an item-by-item account of one firm's communications system. If your organization isn't all under one roof it's a good check list. Don't let your staff blunder because they aren't informed.

Importance of Workable Project Planning **E-48**
Engineering and research and development departments can do a better job with "from-the-ground-up" planning. Here's a brief outline to follow in your organization to improve results.
— H. Warren Roos

DRILLING AND PRODUCING

Engineering, Ingenuity Pay Off on Buzzini Rig No. 8 ..... B-21
Rising Cost of Oil Operations B-25
Resin Cement Aids Waterflood Control B-28
Porosity Determinations from Neutron Logs B-30
Lightweight Drill Pipe in Slim Hole Drilling B-35
Wireline for Offshore Wells B-37
Gamma Ray Density Meter Improves Oil Well Cementing B-40
Delaware Basin: What Traps Its Oil? B-48
Air Drilling with Foam Combats Water Influx B-57
New Christmas Tree B-68
Magnolia's 20 Years of Research B-72
TV Monitor New Aid in Seismic Interpretation B-74
Nigeria Gears for Major Oil Program B-79
API: Beware of Big Government B-84
Economic Outlook for the Drilling Contractor B-85
Record Contender Passes Half Way Mark B-96
Power Swivel Speeds Drilling B-102
Gas Injection in Wilmington Field B-103
Oil Ills: Foreign and Domestic B-118
Oilmen Ponder Public, Social Duties B-125
A Letter to the Class of 1958 ..... B-137

REFINING AND PETROCHEMICAL

MODERN GASOLINE PLANTS
Modern Gasoline Plants — Part 1 ..... C-7
Gas Liquids Looking for Increased Markets C-12
Atlantic Refining Puts Automation to Work C-13
Better Absorber Control, Higher Recovery and Profits C-17
Design Considerations for Gas Purification Processes C-19
Investigate the Hot Potassium Carbonate Process C-24
Electricity from Gas? C-30
Gas Conservation Plants in Western Canada C-31
Fully Automatic Gasoline Plants? C-38
Effect of Variables on Cooling Tower Performance C-40
The Refining Engineer's Process Notebook:
Shell Butane Isomerization — II C-42a
CAA Butadiene Extraction C-42b
Executives Use the Case Study Approach C-43
Calculate Pipe Stresses Efficiently — Part 1 ..... C-44
Technical Papers Highlight WPRA Annual Meeting C-49

OIL AND GAS PIPELINING

SPECIAL FEATURE — GRAPHIC ENGINEERING DIGEST
Graphic Engineering Digest Authors D-19
How Accurate Are These Gas Flow Equations? D-20
How Highway Engineers and Pipeliners Can Solve Mutual Problems — and Save Money! D-24
Where To Get Pipeline Movies D-26
Sonne Photography D-27
Measuring Flow Efficiencies by Ammonia Displacement D-29
Pipeline Field Welding and Quality Control Methods D-32
Crude-Burning Turbines Up Tapline Throughput D-35
Why Automatic Custody Transfer Is Growing D-39
When To Replace a Tractor D-42
Developments to Watch D-44
Automatic Control Systems for Gas Transmission Pipelines D-47
A New Way to Repair Shorted Casings D-48
Pipeline Microwave Reached 21,000 Miles D-50
CATC Will Have Microwave Circle in the Gulf D-50d
PIPELINE FUNDAMENTALS
Pipeline Welding — Part 2 ..... D-51
New Master Control System for Pipelines D-64
Canadian News Notes D-77

FEATURES

The Course of Oil A-4
Advertisers' Index A-6
Highlights A-12
Meetings A-30
Management Personals E-12
Laugh with Barney E-14
The Trade Parade E-16
A Guide to Books E-34
Of Things to Come in Oil B-3
Exploration Activities B-126
What's Doing in Drilling B-130
The Oasis B-140
Running Tour B-142
New Equipment B-155
New Literature B-162
New Refining Projects C-3
Refining and Petrochemical Personals C-51
New Equipment C-55
New Literature C-56
Pipeline Developments D-3
With the Pipeline Contractors D-78
Pipeline Projects D-82
New Equipment D-86
New Literature D-90

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Who Makes Prosperity?

We're worried and confused and sometimes dismayed.

Not about the recession, though our investments look emaciated and the high cost of living has our income on the run.

Not about taxes though we think they are heavy enough to hurt economic progress and we'd like to spend the part we think is wasted.

Not about the Soviets. They've shot their Sputnik and the effect on us was an urgently needed shot in the arm. Nothing else could so quickly have pulled our missile program off the skids and into the air; nothing less could have pushed John Dewey educators into teaching the three R's.

We're anxious and perplexed about the cry from businessmen as well as politicians that the government get us back to boom times right now.

Does anybody really believe government makes prosperity? If any government could, the powerful Soviet dictatorship would surely provide uncurving economic heaven.

There are many influences on economics and government, with its power to tax and power to dilute money value, is one of them. But the core of economic well being is the people of every nation — their skills, their demands, their attitudes.

For instance, in the present slump personal income is the highest in history (February figures) and savings are at an all-time high. For some unknown reason, the people decided to save more than usual. The theoretical economists call it inventory recession or capital investment recession. It can more realistically be called a "saving" recession.

Our worry is not so much what government will do about it — although if politicians begin tossing their make-work dice they'll use up those "savings." We want to know what business and industry leaders are going to do.

For one thing, with long-term planning men in management can space expansion programs to hit the down years, saving on more liberal interest and on larger supplies of material and labor. This would help straighten the business curve as it jiggles upward. The oil industry, with its stable demand and necessarily long-term planning could take the lead in better capital expenditure timing.

Business executives must lead or turn the leadership of economics over to the politicians. Nor is it enough now for management to guard its own company. Management's responsibility must either extend to the whole economic scene or impatient people will turn more economic authority over to government. How eagerly some strong men in high places reach to grasp it!

If we nibble on the "government-can-produce-prosperity" cheese we deserve the trap it baits.

Ernestine Adams

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ADVERTISERS' INDEX

A

Air Preheater Corp. D-68, D-69
Aldrich Pump Company B-15
Allis-Chalmers B-73, D-16
Aluminum Company of America B-17
American Iron & Machine Works Company, Inc. B-143
American Petroleum Institute A-31
American Recording Chart Co. E-22
American Steel & Wire Division of United States Steel E-44
Appleton Electric Company D-10
Armco Drainage & Metal Products, Inc. D-79
Armite Laboratories E-27
Armour Chemical Division, Armour and Company B-156, B-157

B

B & W Inc. B-132
Baash-Ross Division of Joy Manufacturing Company B-51
Baker Oil Tools, Inc. B-20, B-46, B-47
Barold Division, National Lead Co. B-80, B-81
J. B. Beaird Company E-31
Beckman Systems Division, Beckman Instruments, Inc. E-1-e
Black, Sivalls & Bryson, Inc., Oilfield Equipment Division E-25
Born Engineering Co. E-1-f
Brakesel, Inc. E-34
Brewster Company B-11, B-12
Bucyrus-Erie Company, Drill Division B-4
Byron-Jackson Tools, Inc. B-65, B-66

C

Cable Engineering B-138
Cameron Iron Works B-76, B-77
Cardwell Manufacturing Company B-70, B-71
Carrier Corporation C-52, C-53
Catalytic Construction Company C-50
Catawissa Valve and Fittings Company E-24
Caterpillar Tractor Co. E-32
Chicago Bridge & Iron Company C-28, C-29
Christensen Diamond Products B-87
Clark Bros. Co. D-52, D-53
Classified Advertising E-50
The Cleveland Trencher Co. D-70
Climax Engine Manufacturing Company B-97
Coast Paint and Lacquer Company D-6
The Colorado Fuel & Iron Corporation B-69
Continental-Emsco Company B-5
Continental Oil Company B-146
C. Lee Cook Company A-29
Cooper-Bessemer Corporation D-54, D-55
Core Laboratories, Inc. B-127
M. J. Crose Manufacturing Company, Inc. D-61
Crossett Chemical Company Division of The Crossett Company B-128, B-129
Crutcher-Rolfs-Cummings, Inc. D-50-b

D

Davison Chemical Company, Division of W. R. Grace & Co. C-27
Dayton Rubber Company B-88
Dearborn Chemical Company D-7
Dodge Manufacturing Corporation B-18
Dowell Incorporated ..... A-15, B-58, B-59, Inside Front Cover
Dresser Industries, Inc. E-26
Drilling & Service, Inc. B-16
Allen B. DuMont Laboratories, Inc. A-14
Du Pont, E. I., de Nemours & Co., Inc. B-75
The Duriron Company, Inc. D-15

E

Eastman Oil Well Survey Company B-43
Edward Valves, Inc. B-138
Electro-Motive Division, General Motors B-160, B-161
The Elgen Corporation B-6
Engineering Controls Incorporated D-89
Ethyl Corporation C-4, C-5

F

Fairbanks, Morse & Co. B-49
The Federal Process Company E-49
First National Bank in Dallas E-46
The Fish Engineering Corporation D-5
Fisher Governor Company E-10, E-11
Fleetline Co. D-76
Fluor Products Company E-1-h
The Foxboro Company C-6

G

Gardner-Denver Company B-9
Gaso Pump & Burner Mfg. Co. E-1-b
General American Transportation Corporation, Plate & Welding Division E-47
General Precision Equipment Corporation E-28, E-29
General Precision Laboratory, Inc. A-28
Grant Oil Tool Company B-124
Graver Tank & Mfg. Co., Inc. C-39
Grove Valve and Regulator Company B-73
The Guibersen Corporation B-13
Gulf Oil Corporation A-16

H

H & M Pipe Beveling Machine Company D-80
Halliburton Oil Well Cementing Company ..... Back Cover, B-10, B-104, B-105
Hammond Iron Works E-15
Harbison-Fischer Mfg. Co. B-95
Harley Sales Company E-13
Hercules Tool Company B-115
Hill-Hubbell & Company, Division of General Paint Corp. D-8
Hotel Cleveland E-24
Hotel Figueroa E-34
Houston Contracting Company D-88
Houston Oil Field Material Company, Inc. B-89
Hughes Tool Company B-98, B-99
Hydril Company B-41

I

Industrial Nucleonics Corporation E-6
Ingersoll-Rand B-148
Insley Manufacturing Corporation D-9
International Harvester Co. E-51

J

Jensen Brothers Manufacturing Co., Inc. B-135
Jones & Laughlin Supply Division B-110, B-111
Johnston Testers B-78

K

Kane Boiler Works, Inc. D-80
The M. W. Kellogg Company C-47
Kennametal, Inc. E-16
Kinzbach Tool Co., Inc. B-162
Koehring Division of Koehring Company E-39
Koppers Company, Inc. ... E-1-c, D-11, D-50-c, E-27
Kraloy Plastic Pipe Co., Inc. E-33

L

Lane-Wells Company ..... Inside Back Cover
Larkin Packer Company, Inc. B-120
Layne & Bowler, Inc. E-30, E-31
Leland Equipment Company D-87
Lone Star Steel Company A-5
Lufkin Foundry & Machine Company B-8
The Lufkin Rule Company E-27
The Lunkenheimer Co. E-43

Mc

McCullough Tool Company B-109
McEvoy Company B-112

M

Magnet Cove Barium Corporation B-149
The Majestic Hotel E-34
F. H. Maloney Company D-85
Marsh Instrument Co. E-41
John N. Martin, Manufacturer B-141
Martin-Decker Corp. B-141
Mayer-Kelly Company D-82
The Maxim Silencer Company D-77
Merla Tool Corporation B-125
Minneapolis-Honeywell Regulator Co. ..D-50-f, D-50-g
Mission Manufacturing Company B-122, B-123
Lee C. Moore Corporation B-101
Mueller Company E-17, E-18

N

National Supply Company B-53, B-54, B-55, B-56
National Tank Company E-52
Naylor Pipe Company E-42
Nordberg Mfg. Co. D-12
W. C. Norris, Manufacturer A-1

O

The Ohio Injector Company E-21
Oil Center Tool Company B-1
Oil Metering and Processing Corp. B-140
Oil Well Supply Division, United States Steel Corporation A-7, B-92
Orbit Valve Company B-82
Otis Engineering Corporation B-44, B-116, B-117

P

Parkersburg Rig and Reel Co. B-150, B-151
Parsons Company D-17
Peerless Manufacturing Co. A-13
Pelican Supply Co., Inc. D-90
Perforating Guns Atlas Corporation B-93
Permian Basin Oil Show A-30
Petro-Chem Development Co., Inc. C-37
Petroleum Electric Power Association E-38
Chas. Pfizer & Co., Inc. B-136
Philco Corporation D-13
Pipeline Cleaners Co. D-86
Pipeline Inspection Co., Inc. D-76
Pipeline Service Corporation D-14
Pipelinings E-50
Polyken Sales Division, The Kendall Company E-40
Procon Incorporated C-23
The Wm. Powell Company C-35
Proportioneers, Inc., Div. of B-I-F Industries C-21

R

Radiator Specialty Co. C-57
Radio Corporation of America D-58, D-59
Rector Well Equipment Company, Inc. B-152
Reed Roller Bit Company B-144, B-145
The Ridge Tool Company E-14
Rockford Clutch Division, Borg-Warner B-153
John A. Roebling's Sons Corporation A-8
Rockwell Manufacturing Company E-2, E-3
Roper Hydraulics, Inc. B-142
Rust-Oleum Corporation A-9

S

Salt Water Control, Inc. B-100
Schlumberger Well Surveying Corporation B-133
Security Engineering Division B-19
Shaffer Tool Works B-154
A. O. Smith Corporation D-18, D-62, D-63
Newery J. Smith Company C-57
Somerville Construction Co. D-86
Southern Pipe Coating Company D-50-h
Southwest Industries, Inc. B-86
Spang & Company B-147
Standard Oil Company of California E-45
Standard Oil Company (New Jersey) B-37
Standard Pipeprotection, Inc. B-83
Stearns-Roger Mfg. Co. C-54
Steel Forgings, Inc. D-76
Stewart & Stevenson Services, Inc. D-75
Sun Shipbuilding & Dry Dock Company C-1

T

The Texas Company E-36
Texas Employers Insurance Association E-20
Thornhill-Craver Co. D-2
Tinker & Rasor D-84
Transcontinental Gas Pipe Line Corporation A-32
Tretolite Division, The Petrolite Corporation E-1-a

U

Union Switch & Signal D-71
Universal Oil Products Company C-32, C-33

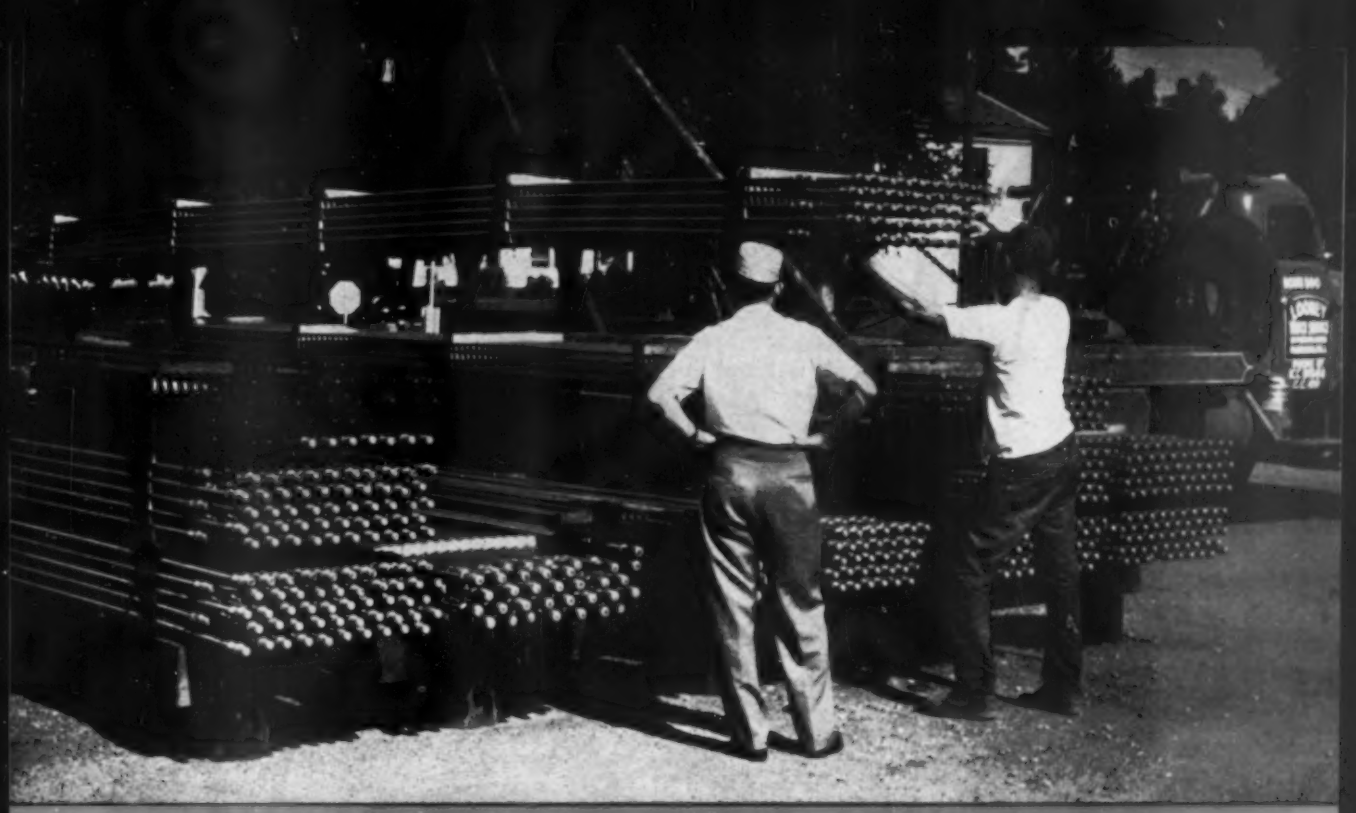
V

The Vapor Recovery Systems Company D-81
Visco Products Company, Incorporated B-39
Henry Vogt Machine Co. C-2

W

W. L. Walker Co. D-78
Walworth Company D-1
Warner Lewis Company D-65
Waukesha Motor Company B-134
Weil Equipment Mfg. Corp. B-7
Welex, Inc. B-61
The Western Company B-2
Western Supply Company C-25
Wheeling Machine Products Company E-23
The Wheland Company B-14
Wilkinson Products Company D-90
Williams Brothers E-50
Williams Pressure Service Company D-72
T. D. Williamson, Inc. D-18-a
Wilson Mfg. Co. B-131
Wilson Supply Co. B-64
Wisconsin Motor Corporation E-19
W-K-M Division, ACF Industries B-158
Wyatt Metal & Boiler Works E-1-d

THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS—THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS



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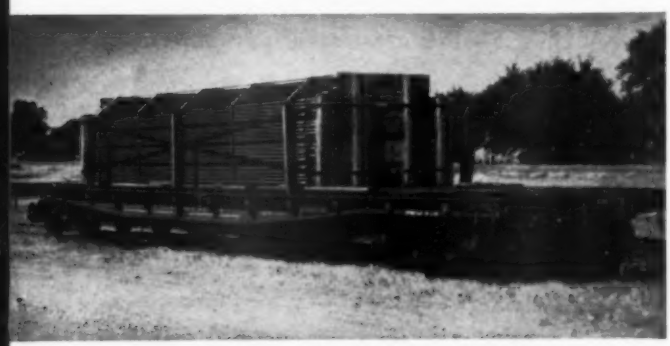

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RUST-OLEUM CORPORATION, 2641 Oakland St., Evanston, Ill.

Please send me a FREE TEST SAMPLE in the color checked:

- ☐ 769 Damp-Proof Red Primer
- ☐ H-50 Primer
- ☐ 634 Quick Drying Black
- ☐ 2766 High Gloss White
- ☐ 470 Ready Mixed Aluminum
- ☐ H-4 Caterpillar Yellow
- ☐ 722 Bethlehem Yellow
- ☐ 728 Old Emsco Green
- ☐ 726 New Emsco Green
- ☐ 727 New Unit Rig Gray
- ☐ 724 Waukesha Gray
- ☐ 725 New National Blue
- ☐ 723 Oil Well Orange

THE CONFERENCE TABLE

We have given you a republic, if you can keep it . . . . . BENJAMIN FRANKLIN

Trends

- *More exploratory drilling compared to development.*
- *Growing interest in foreign concessions.*
- *Building processing capacity to meet expected rise in asphalt needs.*
- *Diversification geographically and in kinds of business.*
- *Stress on research to improve methods and products.*
- *More attention to rise in labor costs and their relation to productivity.*
- *Growth of new companies as older ones merge with or purchase others.*

These are some trends indicated in annual reports covering 1957. (See survey beginning on page A-17.)

One particular advancement is improvement in presenting facts about the company to stockholders. When we began the annual report survey 12 years ago, we found them interesting. Today they are incomparably better. They contain more facts given in simple historical fashion. That's not the whole story. They are full of new ideas, new plans, new hopes for building the company. They make entertaining and enlightening reading. They evidently please stockholders because the number attracted to oil stocks has risen sharply.

Motivation in selecting stocks might make an interesting study. Using our own experience, we want an interest in a company we own and a good annual report creates identification with the company. There is a gossipy tone to some reports that really makes you feel you're having a chat with the president. What an improvement over the staid tables of confusing figures of some years ago!

Our Creed

Leonard Refineries, Inc. recognizes the American Corporation as the fourth organization of society to achieve the status of a perpetual institution, the others being the Church, the State, and the University.

We believe that a perpetual institution has and must accept inherent responsibilities to all people.

We believe that the Good Citizenship responsibilities of the American Corporation include developing and maintaining a climate in which there can exist:

a constant search for ways to encourage greater creative knowledge and creative manpower;
a free and competitive economy in which all people may share, as workers at fair wages, as investors at a fair rate of return, and as customers paying fair prices for quality products.

We, the entire membership of the Board of Directors, approve and accept the above as the creed for Leonard Refineries, Inc.

This was signed by directors and published in Information Handbook of Leonard Refineries, Inc.

Company Political Action

General Electric, which has been a pioneer in many fields, has launched an entirely new idea — it will have its own political action group. The new section is called a government relations service and may be industry's answer to labor's political action committees. This follows the proposition that industry has as much right as labor to educate employees and to join with other companies to intensify the public interest in government and politics on all levels. Jack Parker, vice president, states these principles of the G.E. committee:

1. *Identification of general government trends.*
2. *Development of background information on public issues that affect business.*
3. *Further development of general political understanding within the company as this becomes increasingly essential for all business management.*

Management has been inclined to leave political activity to labor or touch it with a distant word. It may not be as dignified to get into the fight against socialistic trends, but it's a lot better than getting defeated without even giving our beliefs breathing space.

Capital Expenditure Statistics

The reader must be puzzled sometimes when he reads the various figures given by different economists on capital expenditures in the oil industry. Most of the industry publications make some sort of estimate. Chase Manhattan Bank has provided estimates for as many years as any institution, API uses their figures and sometimes supplies its own. *The Petroleum Engineer* has been making estimates for 12 years.

Much of the variation is due to the limitations imposed by the economists on one hand, and by the accounting practices of the oil companies on the other. We have several times referred to a short article in *The Petroleum Engineer*, January 1957, page A-28, which goes into some of the wide divergencies among petroleum producers for leaseholds, exploration, and development costs. It gives some idea of the difficulty in separating exploration and production capital expenditures.

For instance, accounting treatments given by 61 oil companies to payments to outside exploration companies for work on acreage later taken as a result of the survey, indicated three companies had no such work, 22 expensed the full cost, 23 companies capitalized the full cost, and 13 companies capitalized part of the cost. This is just one indication of the shaded division between exploration expenditures and production expenditures.

The same is true when there is an attempt to divide expenditures for domestic and for foreign operations. Most companies simply do not give separate figures until actual data is in. As one company reports: We may have to pour money into a certain area because of events. Some companies divide expenditures into Eastern and Western Hemispheres but this does not aid in the foreign-domestic division. Estimates of capital outlays have proved helpful in planning. They are based on actual decisions for spending and are strong indications of future moves.

Practical Public Relations

Getting down to cases is always difficult in an intangible field. The IPAA is making a valiant effort to inspire its members to make factual contributions to that vaguest of intangibles—public relations. Under "Public Information Digest" a report is made on what IPAA people have done to improve public relations. In the *Independent Monthly* Alf R. Thompson, of Mattoon, Illinois, is the committee chairman, and vice chairman is Sam T. Mallison of Pittsburgh.

The report publishes some answers to criticisms of the 27½ percent depletion, the gas bill and other industry problems. Not only does it demonstrate how the fight is carried on but it also gives excellent tips on how you can answer attacks you hear.

Automation can accomplish many things faster and more accurately, but it never can outdo the human processes that created it.

Really on the Fringe

New York State Labor Department reports that the contract of a painters' union gives a worker his birthday off with pay plus a $5 birthday present from the boss.

A machinists' local pact provides that workers quarantined at home because the kids have measles or mumps must be paid for the time they're away from work.

Brewery workers get free beer on the job and bagel bakers get a bagful of bagels a day.

You "Auto" Buy Now

Having always bought now, as far as our resources lasted, we didn't know how we could promote the campaign to get other people's money out of their respective socks, banks, or wherever they put their savings. The only thing we can do is pass on this story, which will make you think twice about "You Auto Buy Now."

The nervous relatives were all gathered in the lawyer's office eagerly waiting for him to read Uncle Jasper's will.

The lawyer read: "Being of sound mind, I spent all my money."

Here Are Your Motivations

A psychologist, Dr. C. Gilbert Wrenn of Minneapolis, says that one of the most common misconceptions of human behavior is that people can control their emotions. He maintains that you can control the outward expression of your feelings, but you are powerless to control what happens to your viscera. You may keep your friends from knowing you are excited or depressed, but the emotion automatically affects your vital organs — your digestion, respiration, heartbeat. He gave four motivating forces that run throughout life:

1. Love is man's most basic motivation. All through life we are either seeking affection or if we have someone who loves us, trying to protect the source of our love.

2. Need for security. Economic security, contrary to what most businessmen believe, is not the most important kind.

3. Need for prestige and acceptance. This explains the rush to join organizations, and the hunger for publicity. Oddly enough, the more intensly a person shuns publicity, the greater is his need for it.

4. Need for self-realization, or discovering what one can contribute to the world. "This is the apex of motivation; it is useless to appeal to this need unless the other three needs have been met."

Probing Unknown Depths

Sometimes we run into personnel techniques that seem to ignore personality. If people are getting as standard as some of these papers imply we are almost ready to lose interest in the human race. The reason we haven't is because we don't believe it. People are not only funny (cia Art Linkletter) but each one is different.

In the booklet "Executive Selection, Development, and Inventory" (published by American Management Association, Inc., 1515 Broadway, Times Square, New York 36, New York) we are inclined to bog down when we get to a chapter on "How to Use Failure to Gain a Promotion as a Positive Tool for Management Development." Maybe you can follow this formula.

On the other hand there are some articles that will help you select, develop, and keep good executives. One of these is "An Integrated Approach to Management Development" by Willard E. Bennett, a well known writer in the petroleum industry. He is labor relations superintendent for Cities Service Refining Corporation, Lake Charles, Louisiana.

Fashions From Well Cores

If you haven't got oil in your well, maybe you can sell the core. A Dallas store, A. Harris and Company, has introduced articles made from oil well cores. There are lighters, paper weights and men's jewelry fashioned from the hard cores, which come mostly from the Permian Basin of West Texas.

First Quarter Slump

In the first quarter last year U. S. producers were shipping 940,000 bbl a day to oil-hungry Europe, cut off from Middle East supplies. In the first quarter in 1958 about 260,000 bbl a day left the U. S. Domestic demand remained about the same.

Income for the first quarter reflects this change in foreign demand.

Table 1. Income for First Quarter 1958.

Company	Gross income ($1000) 1958	Gross income ($1000) % of 1957	Net income ($1000) 1958	Net income ($1000) % of 1957
Atlantic	144,811	85	2,695	16
Champlin	18,610	89	1,602	39
Continental	141,743	91	10,699	78
Cosden[2]	70,542[3]	139	4,124	95
Eason	2,205	104	422	111
Fifteen	616	75	219	84
General Crude	2,905	78	620	62
Gulf	—	—	60,638	64
Monterey[1]	11,688	104	1,491	104
Murphy Corp[4]	7,061	206	905	390
Quaker State	12,467	89	289	78
Seaboard	12,439	91	2,008	59
Shamrock	13,985	96	2,675	100
Shell	408,626	87	26,500	64
Standard Calif.	361,335	86	57,411	83
Sun	—	—	3,574	27
Superior[5]	26,127	102	3,771	87
Texas Co.	—	—	70,003	81
Texas Pacific	5,841	86	1,496	72
TXL	—	—	942	93
White Eagle[6]	2,955	98	150	89
Wilcox	2,394	87	189	75

[1] Six months ending February 28.
[2] Nine months ending January 31.
[3] 1957 data reflects acquisition of Colorado City refinery only about two months; 1958 all nine months.
[4] First quarter ending August 31.
[5] First quarter ending November 30.
[6] First quarter ending December 31.

HIGHLIGHTS

★ ★ ★

Digest of News and Comment

Many Back Ikard Bill

Independent producers' associations, not satisfied with the administration's "strengthened" voluntary imports policy, are backing Congressman Frank Ikard's (D-Texas) "Mineral Securities Act of 1958." The bill, described as a "quota-tariff combination" program, would limit oil imports by requiring licenses of importing companies. The licenses would be awarded on a competitive bid basis. Proponents say the bill will "be in keeping with United States foreign trade policies."

Conoco Hikes Advertising

Introduction of two new motor oils by Continental Oil Company will be supported by the most concentrated advertising campaign in its 82-year history. The program involves newspaper, radio, television and outdoor advertising and will center around a jingle-type contest with $50,000 in prizes. First prize in the contest is a Cadillac loaded with $10,000 in cash. The company, confident of the new oils' success, is offering to guarantee a new car's engine for "50,000 miles against mechanical failure due to lubrication."

Refineries Still in Business

Rocket fuels may be all right for moon travel, but they'll never take us to the grocery store or to visit Aunt Minnie. New fuels now being perfected for missiles and rockets "will never put our oil refineries out of business," assures Dr. W. H. Schechter, vice president, Callery Chemical. Limitations and costs of boron and other new fuels are prohibitive for "consumer use," he said. "Rocket fuels may some day send man to the moon, but they will never power his motor car."

Auto Makers Push Refiners

Advanced automobile engine design and performance will seriously tax the capability of any refinery to produce octane during the next six years, states W. J. Service, The Pace Company. Service told a WPRA audience that costs would rise more than two cents per gallon by 1963 because of continued increases in engine compression ratio and resultant increases in octane number.

'Who's Who' Cites Gulf Oil

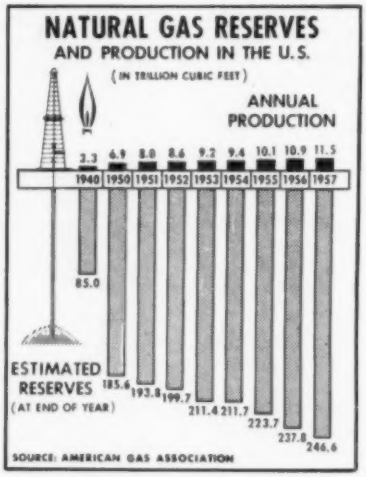
Gulf Oil Corporation has been awarded an honorable mention by the editors of *Who's Who in America* for its "exceptional corporated educational philanthropy." Awards are given biennially in recognition of most significant corporate gifts to the American educational system, and are based on uniqueness of the program as well as the size of the gift. Gulf's Aid to Education Program includes merit scholarships, alumnus gift matching, faculty salary supplementation, direct grants to independent colleges, departmental assistance and graduate fellowships.

Standard Awards Fellowships

Three university faculty members have been awarded $5000 fellowships by the Standard Oil Foundation, Inc. (Indiana) in the first of a new kind of fellowship to upgrade instructors in physical science and engineering fields. The three one-year fellowships provide $5000 each to I. E. Morse Jr. of Michican State University; R. A. Strand, Pennsylvania State, and J. A. Weese, Cornell. These were chosen from 20 applicants by officials from 40 universities in the U. S. The fellowships will permit the instructors to do further work on doctorate degrees in the field of their choice.

Buys Into Field

General American Oil Company of Texas has purchased Forest Oil Corporation's interest in the Dora Roberts field, Midland County, West Texas, for $16,000,000. Production for the Forest interest in 1957 was about 2600 bbl a day.



Natural gas reserves in the United States advanced to an all-time high of 246.6 trillion cubic feet over the previous year. Production during 1957 hit a record of 11.5 trillion cubic feet but additional proved recoverable reserves amounted to 20.3 trillion cubic feet.

More Work for Carson

Captain M. V. Carson, already head of the President's voluntary oil import program, has been appointed director of the Office of Oil and Gas. Carson succeeds Hugh A. Stewart, who resigned February 28. The appointment was made by Secretary of Interior Fred Seaton. At the same time, Seaton announced the volume of February crude imports into the U. S. was about 812,000 bbl per day. Carson used the statistics to point out that the voluntary program he has been administering is working, and is currently 17 percent below the established level. Carroll D. Fentress, formerly assistant director of the Oil and Gas Office, acted in the executive capacity in the interim period prior to Carson's appointment.

22 Governors Demand Curb

Mandatory crude import curbs — pushed back to 1954 ratios — are being further pressed for by 22 governors. Led by Texas Governor Price Daniel, the group joined together to ask the curbs in a telegram addressed to President Eisenhower. The administration's new volunteer plan linked with the Buy American Act has failed to satisfy demands of most domestic producers and oil state governors.

AAPL's TIPs Take to TV

Timely information on petroleum (TIP) is being beamed to more than 200,000 each day, in an extension of the American Association of Petroleum Landmen's TIP program. The TIPs are aimed at bringing the public to a closer understanding of the oil industry. AAPL, which has been mailing the attractive and informative cards for some time, initiated TV program in Fort Worth. Information in each TIP, mailed or broadcasted, points out the competitive nature of the industry. (See table below.)

Timely Info on Petroleum

Talk About Industry Competition!

Percent of Total Production By 4 Largest Companies in Each Industry

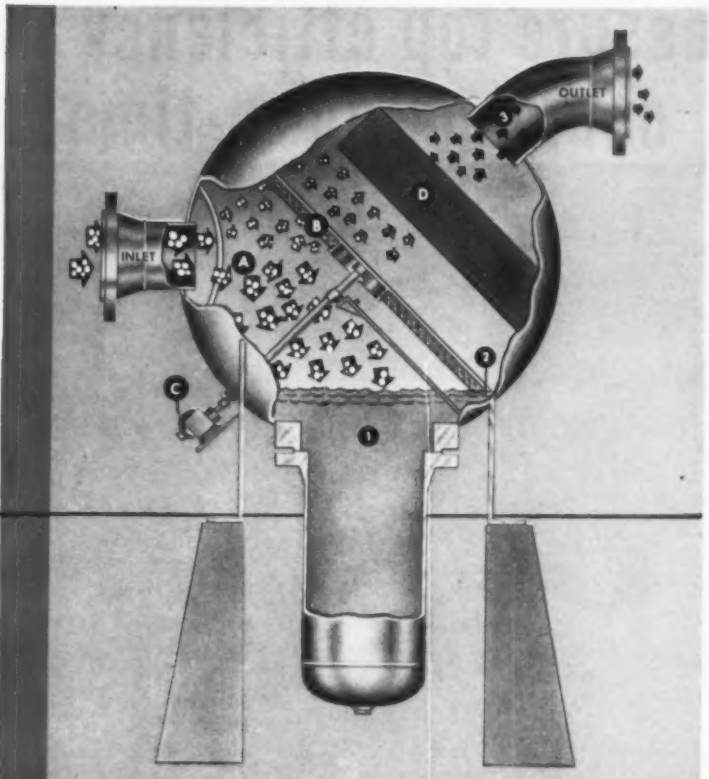
Light Bulbs	100%
Automobiles	90%
Cigarettes	85%
Sugar	80%
Copper	80%
Soaps	80%
Woolen Fabrics	75%
Tires	70%
Oil	19%

— American Association of Petroleum Landmen

MORE EFFICIENT RESULTS!

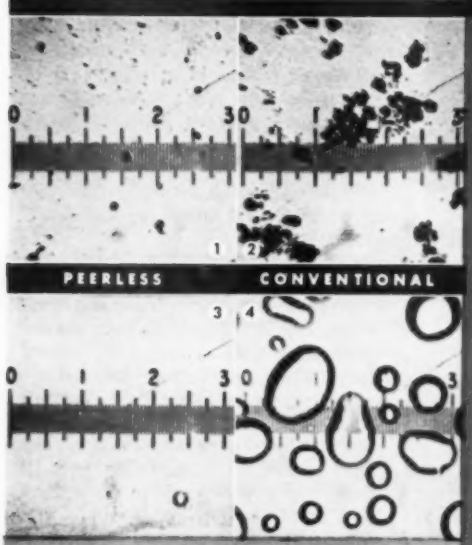
PEERLESS SCRUBOSPHERE*

*Spherical scrubber for dust and liquid removal from gas flow



LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).



These photographs were made of microscope slides introduced downstream of the Scrubosphere and a conventional vertical oil bath cleaner under the same operating conditions. Plates 1 and 2 show the comparative amounts of iron oxide not removed with the amounts introduced being identical. Plates 3 and 4 indicate comparative oil loss with vapor rate through the vessels being the same.

LOOK AT THIS TEST The test at the left indicates the superiority of Peerless Scrubosphere over conventional oil bath dust scrubbers. The SCRUBOSPHERE operates with no loss of efficiency at low flows, minimum liquid loss, and very low pressure drop. Other outstanding features include easy vessel access with removable self cleaning contactor, a sump for slugs of solid or liquid particles, and minimum cost.

For detailed information write for Bulletin No. 180

PEERLESS MANUFACTURING CO.

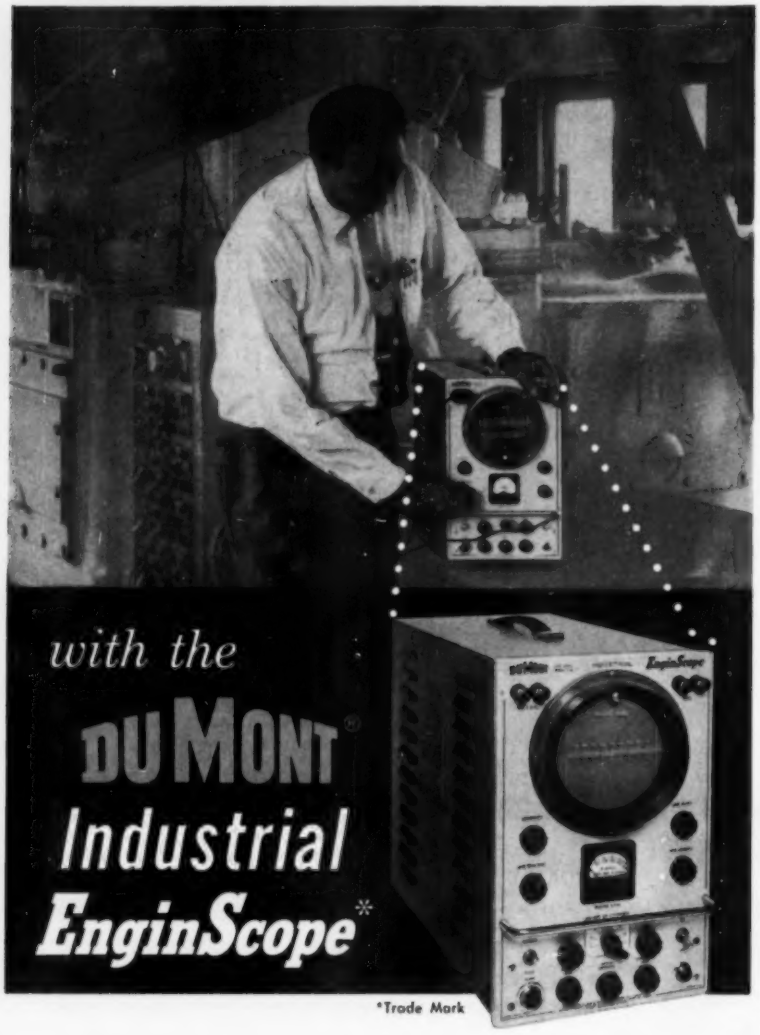
P.O. Box 13165 Dallas, Texas

Representatives in All Principal Cities

PEERLESS MFG. CO. DALLAS TEXAS

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

assure top efficiency and minimum down-time...



*Trade Mark

Instantaneous, dynamic analysis of total performance provides information that greatly simplifies both routine and emergency service of low-speed, industrial spark-ignited engines.

The famous Du Mont EnginScope that is making history in the automotive service field is now available in a **special model** specifically intended for the industrial engine field. The Industrial EnginScope analyzes through the **secondary** ignition voltage, thus accurately indicating conditions at the actual ignition point of the engine.

- ★ **Connects to engine while running.**
- ★ **Assures top operating efficiency of engine.**
- ★ **Reduces routine maintenance costs.**
- ★ **Reduces down-time by "forecasting" faults.**
- ★ **Easily used by technical, or non-technical personnel.**

Write for complete details...

Dept. PE4
Automotive Equipment Division
ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J.

Highlights

Memphis Case Forces Cut

Construction previously planned this year by Tennessee Gas Transmission Company has been slashed 40 percent because of problems arising from the Memphis case decision. Gardiner Symonds, president of the company, has indicated that the cutbacks were due to negotiations with customers for new agreements to solve problems arising out of the case. The U. S. Supreme Court is now hearing arguments in the case, which as the ruling now stands, would require all customers to approve a gas price increase before it could become effective. Specific TGT expansion eliminated or postponed has not been announced.

Union Oil Center Opens

The more than 1200 headquarters employees of Union Oil Company of California have moved into the new Union Oil Center in Los Angeles. For the first time in several years the personnel will be housed in a single building. The employees were previously in six different buildings. The Center itself, a modern and functional group of office buildings, was three years in construction.

In-Oil Payments Fully Taxable

The Supreme Court has decreed that in-oil payments are taxable as ordinary income rather than at the lower capital gains rate. Congressional legislation, which has until now been withheld, is expected to be set in motion. The in-oil payments, or payments for rights to future oil production, entitle the holder to receive a specified sum of money payable out of a particular portion of production and entirely free of production expenses. The government contended that the sum received was simply carved out of a larger mineral interest and taxable as such.

190 Firms Seek Foreign Oil

Approximately 190 American companies are active in oil exploration and production in 91 countries and account for 598 separate foreign national operations, reports Leonard M. Fanning in a special survey. The study points out that there were only 28 companies with foreign oil interests in 1945. Of the group now engaged in exploration and/or production outside the U. S. now, 68 have no domestic production or exploration activity. The present group, Fanning says, is composed of 74 large or sizable publicity-owned corporations, 100 small companies and 16 partnerships and individuals. More than 10,000 U. S. citizens are employed abroad by these oil companies.

Good Wells Make Good News

A Special Report on Successful Remedial Cementing Jobs

May, 1958

The success ratio of remedial cementing jobs has been materially improved since the introduction of Cealment®. Cealment is the exclusive Dowell cementing service, using a latex-cement. It is especially suited to remedial work. Here are four examples of successful application.

- **Stonewall County, North Texas.** (New Oil Well) This well was completed in the Strawn sand through perforations from 5110 to 5130 feet. Initial production was only 10 bopd with 70 bwpd. A 500-gallon squeeze was performed with Cealment, and the well was reperforated. *After fracturing, well tested 106 bopd with no water.*

- **Carbon County, Wyoming.** (Old Oil Well) This well, producing from 5852 to 6251 feet, was completed open hole in 1948. Recent attempts to stimulate production from selected intervals of the pay, with the aid of packers set in the open hole, had failed. The operators decided to set a 5" O.D. liner in the 400 feet of 6⅛" open hole. The liner was run, cemented with Cealment and perforated. Following a stimulation treatment, *production rose from 136 to 357 bopd while water production dropped from 209 to 27 bwpd.*

- **Cowley County, Eastern Kansas.** (New Oil Well) This Layton sand well was in an area noted for water problems due to cement channeling. For example, most wells in the pool produce three to five barrels of water to each barrel of oil. One offset well had been "squeezed" twice with regular portland cement, fractured three times without success, squeezed a third time, and then finally abandoned. The operators decided to try Cealment on this new well. A squeeze was performed at 2022 feet with 400 gallons Dowell latex-cement preceded by 200 gallons Mud Acid. Then a retainer was set at 1998 feet; and the well was squeezed at 2003 feet using 400 gallons of latex-cement with a spearhead of 50 gallons Mud Acid. Cement and retainer were drilled out, and the well was perforated from 2010 to 2014 feet and fractured. *After treatment, the well swabbed three boph with only two bwph.*

- **St. Landry Parish, South Louisiana.** (Old Oil Well) This well was completed through perforations from 8715 to 8722 feet. A channel in the primary cement job resulted in high salt water production. This posed a water disposal problem and prevented maximum allowable oil production. A squeeze of 900 gallons latex-cement, preceded by 200 gallons Mud Acid, was performed to cement off the channel. The job was completely successful. *The channel was repaired and water-free production was possible at top allowable.*

A recent survey of 866 cementing jobs using Cealment disclosed Dowell's latex-cement has proved exceptionally successful in all kinds of cementing work — primary cementing, tailing-in, setting liners, squeeze, plug backs and lost circulation. Ask for a free copy of this survey. For service or full information, contact your nearest Dowell service point. There are 165 in the United States and Canada. In Venezuela, contact United Oilwell Service. Dowell Incorporated, Tulsa, Oklahoma.

Services for the oil industry DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

C. E. Williams, Gulf Sales Engineer, Midland, Texas, and G. W. Ramsey, Assistant Plant Superintendent, inspect force feed lubricators on one of the modern gas engines at the Goldsmith plant of El Paso Natural Gas Company.

No lubrication problems in 8 years of operation

Since 1949, twenty-seven gas engine-compressor units developing 39,985 horsepower at the Goldsmith plant of El Paso Natural Gas Company have been thriving on Gulf Security Oil. Bearing, ring and cylinder wear maintenance records have been excellent.

Insure safe, more effective lubrication protection for *your* compressor units. Specify Gulf Security . . . the high quality, straight mineral oil. For full information, call your nearest Gulf office.

GULF®

GULF OIL CORPORATION, Dept. DM, Gulf Building, Pittsburgh 30, Pa.

1957 Topples All Records!

Revenues Up 14%

Earnings Up 8%

Capital Outlays Up 14%

Net Worth Up 12%

Ernestine Adams

'BECAUSE 1957 ENDED IN A DOWNTREND with general business indexes lower, many have considered it an unsatisfactory year. On the facts it was a good year, indeed one of the best."

So states Phillips Petroleum Company in its 40th annual report.

That statement is true of the whole industry. After increases of 13 percent in earnings for 1956 over 1955, companies in this survey had a good 1957 despite a number of problems. Revenues went up 14 percent over the record year of 1956 and earnings were 8 percent higher.

Drilling and Exploration's report read: "Drilexco has just concluded one of the best years in its history. Despite the depressive effects of world-wide oversupply of oil, mounting costs and wages, and ever-keener competition, the drilling division made a very creditable showing."

Reported Superior Oil Company: "The year just ended has been the most profitable in the company's history with new highs being recorded in production, sales and earnings."

"In 1957, production, gross revenue and net earnings all registered increases over the preceding year," Midwest Oil Corporation told stockholders.

There is no doubt about it, 1957 was the best year the U. S. industry ever experienced.

Annual report comments indicate 1958 will be about the same story — backwards. That is, the first half will be on the low side, like the last half of 1957 and the last half should see an upturn although not as strong as that in the early months of 1957, when the Suez crisis opened temporary markets.

Miss Adams is Management Editor

Cities Service's report described last year's conditions thus:

"The year opened with both worldwide and domestic demand for petroleum and its products at the highest level of all time. In the final months, the industry's zeal for producing had created unwieldy surpluses of refined oils. This in turn brought distress pricing and the spread of price wars."

Yet the company goes on to point out, "it is worthy of note that, while several other key industries encountered a falling off in consumer demand during 1957, total demand for oil products actually exceeded 1956 by 1.3 percent. It is estimated that 1958 will show an increase over 1957. Thus, it appears evident that the present problems of the domestic oil industry can be attributed directly to production excesses in the keenly competitive race for business."

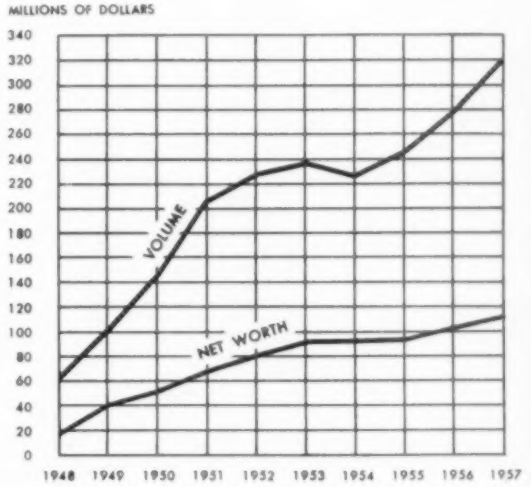
One report mentions unfavorable weather. Pure Oil says:

"The petroleum industry is uniquely susceptible to bad weather. Unfavorable week-end weather, which was the rule rather than the exception in 1957, adversely affects the consumption of motor fuel. Moreover, unexpectedly numerous and severe hurricanes, tornadoes, and floods seriously handicapped the entire industry, both production and sales-wise."

There is little crying over past difficulties. Even the imports question is viewed calmly, natural gas legislation is mentioned less than last year and the percentage depletion provision is practically ignored in 1957 annual reports.

In the face of lower production and unseasonably soft product prices, Cosden Petroleum sets its goal in steadfast terms: "All we can do is what we have done in the past and will continue do-

Comparison of Sales Volume and Net Worth



Ashland Oil and Refining indicates here that its volume climbs faster than net worth of the company, showing increased efficiency.

- **Revenues Up 11%**
- **Earnings Up 8%**
- **Direct Taxes Down 2%**
- **Excise Taxes Up 10%**

1957 Compared to 1956

TABLE 1. FINANCIAL STATISTICS OF 67 U.S. PETROLEUM COMPANIES FOR 1957.

	Income				Taxes			Per common share[4]				
Company	Gross ($1000)	% of 1956	Net ($1000)	% of 1956	Direct $1000[1] 1956	Direct $1000[1] 1957	Collected for govts[2] ($1000)	Common stock[3] 1000 sh	Price 12-31-57	Net income	Direct taxes	Dividends
Amerada	$ 116,385	108	$29,949	113	$9,611	$12,392		6,313	$ 90⅛	$4.74	$ 1.96	$2.00
American Petrofina	44,086	284	1,543	271	394	2,551		6,256	10¼	0.29	0.49	3%s
Anderson-Prichard	71,076	105	5,243	89	2,148	1,382		1,644	23	2.93	0.84	1.20
Argo Oil	14,181	116	4,921	109	4,770	5,562		1,936	21¾	2.51	2.87	1.25
Ashland O & R[5]	320,249	114	16,219	120	13,800	16,320		5,729	15	2.52	4.30	1.00s
Atlantic	572,237	104	35,670	75	26,808	18,108	83,569	8,987	37⅜	3.82	2.01	2.00
Aztec O & G	2,770	122	1,001	160	150	183		2,280	12⅛	0.44	0.08	None
Bishop	2,539	90	267	61	151	5		563	10⅜	0.47	0.08	0.20
British American	310,118	111	32,180	128	18,934	17,894		10,113	34¼	1.74	1.77	1.00
Champlin O & R	69,396	103	9,703	102	1,900	1,600		4,124	17¼	2.28	0.39	1.00s
Cities Service	1,060,419	108	59,179	95	49,938	41,427		10,519	49⅜	5.63	3.94	2.40
Clark O & R	88,047	113	1,422	57	2,513	1,483	15,268	1,332	12½	1.07	1.11	8%
Colorado O & G	35,489	121	2,855	106				3,032	13¼	0.75	None	None
Continental	614,254	106	46,724	90	29,102	19,619	68,800	19,628	42⅛	2.38	1.00	1.60s
Cosden[5]	71,922	129	6,046	131	3,759	5,302		2,584	15⅛	2.55	2.24	1.00
Crescent	2,885	152	542	423	7	34		2,532	15½	0.38	0.13	0.25s
Delhi-Taylor	67,949	113	3,948	193	1,094	1,171		5,317	10⅝	0.75	0.22	None
Douglas Calif.[6]	28,693	120	554	235	35	380		1,151	3¼	0.42	0.33	0.02½
Drilling & Exp	12,483	107	1,053	188		115		1,896	5⅛	0.56	0.06	0.25
Fifteen Oil	2,870	116	1,043	104	226	210		1,293	9	0.81	0.17	0.30
General American[7]	26,020	108	9,085	104	1,697	1,680		2,959	25⅛	3.06	0.57	37½s
General Crude	13,786	107	3,135	101	1,139	1,155	223	1,852	23	1.69	0.62	1.00
Getty	33,834	163	14,638	186	2,703	4,500		15,166	23⅜	0.93	0.30	5%s
Gulf Oil	2,730,085	117	354,284	125	154,197	202,466	408,949	31,131	107¼	11.38	6.50	2.50s
Hancock[8]	56,347	104	7,125	100	740	1,258	9,932	3,502	28½	1.96	0.36	0.60s
Honolulu	115,662	106	14,538	105	4,924	6,044		3,751	42¼	3.88	1.61	2.00
Humble[5]	1,270,827	107	175,910	98	79,715	65,673		71,828	56	2.45	0.91	1.35
Husky[6]	28,472	99	2,375	88	572	507		3,067	7¼	0.68	0.17	None
Kerr-McGee[9]	109,365	121	6,245	133	1,900	3,000	7,904	2,374	41½	2.55	1.26	0.80
Leonard Refineries	57,802	103	2,509	110	2,480	2,438		1,118	11½	2.24	2.18	0.70
Louisiana Ld. & Exp.	35,407	132	19,333	132	9,071	12,255		8,956	40⅜	2.16	1.37	1.45
Midwest Oil	19,252	117	6,755	103	2,073	2,666		2,537	27	2.66	1.05	1.05s
Monterey[10]	23,433	113	1,294	51	1,119	1,187		1,806	19	0.72	0.66	0.40
Murphy Corp.[11]	20,389	156	2,753	156	866	1,188		2,351	25	1.17	0.51	None
Ohio Oil	291,982	105	41,490	101	19,624	22,281	32,106	13,127	28¾	3.16	1.70	1.60
Phillips	1,136,893	109	96,209	101	54,916	62,904	121,000	34,351	36⅝	2.80	1.83	1.70
Plymouth	117,158	103	6,027	76	4,512	2,726		2,510	23	2.39	1.09	1.60s
Pure Oil	513,368	105	35,524	97	23,038	19,210	107,101	8,602	30	4.13	2.23	1.60
Quaker State	51,004	97	1,983	100	2,745	2,586	5,866	825	23¾	2.40	3.13	2.00
Richfield	255,381	101	28,176	106	24,300	18,163	65,251	4,000	58½	7.04	4.54	3.50
Seaboard	52,299	111	11,159	119	207	560		3,659	57½	3.05	0.15	1.00
Shamrock O & G[12]	55,516	106	8,775	97	4,107	3,630		3,451	27¾	2.54	1.05	1.40
Shell Oil	1,773,359	108	135,085	99	114,372	89,662	282,486	30,286	68	4.46	2.96	2.00
Signal O & G	75,736	122	13,053	122	2,577	2,908		1,014	39½	3.03	2.87	0.70s
Sinclair	1,251,069	106	79,308	88	71,860	53,905	220,000	15,297	61½	5.18	3.52	3.00
Skelly	263,182	105	36,785	108	19,248	18,507	27,399	5,746	53	6.40	3.22	1.80
Socony-Mobil	3,018,348	108	220,000	88	161,399	141,664	320,000	48,310	47½	4.63[13]	2.97[13]	2.50
South Penn Oil	57,534	94	5,874	97	4,998	4,159	5,309	1,703	31⅛	3.72	2.44	2.75
Standard Calif.	1,740,005	111	288,230	108	119,105	97,804	200,615	63,224	45⅞	4.56	1.55	1.90
Standard Ind.	2,030,000	106	151,510	101	89,131	85,668	361,380	35,769	35⅞	4.27[13]	2.41[13]	2.11
Standard N. J.	7,978,314	110	805,177	100	769,200[14]	792,400[14]	530,400	203,488	49⅞	4.08	3.49	2.25
Standard Ohio	377,487	103	23,920	90	24,440	16,193	76,298	4,827	42¼	4.79	3.35	2.50
Sun Oil	778,719	106	47,492	85	46,985	35,628	166,296	11,397	69	4.17	3.13	1.00s
Sunray Mid-Con.	358,201	108	57,155	126	26,438	34,123		17,357	20½	3.09	1.97	1.26
Superior[10]	110,685	123	18,877	374	5,223	9,370		422	1670	44.71	22.20	None
Texas Co.	2,449,162	112	332,304	110	142,577	153,745	420,386	55,937	62⅛	5.94	2.75	2.35s
Texas Gulf	20,996	125	6,830	121	1,747	2,490		4,029	24	1.60	0.62	0.60s
Texas Pacific C & O	24,865	104	7,232	100	2,410	2,431		3,597	27⅞	2.01	0.68	1.00
Tidewater	596,263	112	34,937	90	18,451	11,731	89,639	12,595	19⅞	2.54	0.93	5%s
TXL Oil[13]	11,553	123	4,346	117	1,578	1,537		5,574	13⅞	0.78	0.28	None
Union Calif.	436,731	109	38,200	112	14,830	15,910	77,890	7,717	41⅛	4.95	2.06	2.40
Union O & G of La.	33,241	118	6,782	204	1,194	65		1,818	44⅝	3.73	None	0.80
Universal Consolidated	8,807	116	3,563	106	1,305	1,418		959	42	3.72	1.48	2.60
Utah Southern	3,968	104	1,006	84	418	328		1,200	15¼	0.83	0.27	0.70
White Eagle[7]	11,696	97	770	104	57	128		1,679	6½	0.46		10%s
Wilcox	8,403	98	891	114	242	234	1,272	295	31	3.02	0.79	1.00s
Woodley	7,559	125	3,290	147	313	354	82	788	42	4.17	0.46	0.50s
TOTALS	$32,931,563	111	$3,291,370	108	2,137,454	$2,103,490			$3,819⅜	$232.92	$124.17	$77.52s

S. Also stock dividend.
[1] Not including payroll taxes.
[2] Taxes on sales.
[3] Issued.
[4] Adjustments for stock dividends.
[5] Owned 80% by Jersey Standard; 20% included in totals.
[6] Fiscal year ends June 30.
[7] Fiscal year ends September 30.
[8] Fiscal year ends April 30.
[9] Fiscal year ends March 31.
[10] Fiscal year ends August 31.
[11] Fiscal year ends May 31.
[12] Fiscal year ends November 30.
[13] Based on average shares outstanding during year.
[14] In addition Jersey paid import duties of $895,300,000 in 1956 and $977,600,000 in 1957.

- **Gross Fixed Assets Up 9%**
- **Net Fixed Assets Up 16%**
- **Working Capital Up 4%**
- **Long Term Debt Up 8%**
- **Net Worth Up 12%**
- **Capital Outlays Up 12%**

1957 Compared to 1956

TABLE 2. CAPITAL ASSETS, CAPITAL EXPENDITURES, AND CHARGE-OFFS OF 67 COMPANIES.

Company	Years in business[2]	Gross fixed assets $1000	Net fixed assets $1000	Working capital end 1957 $1000	Long term debt $1000	Stockhldrs equity[6] (net worth) $1000 12/31/57	Depreciation depletion, amortization[5]	Capital and exploration expenditures[7] $1000		
								1956	1957	1958 est.
Amerada	37	408,160	92,462	53,740	none	146,622	39,638	49,350	51,025	—
American Petrofina	2	70,923	47,879	19,375	14,807	52,929	3,824	New Co.	37,762	—
Anderson-Prichard	36	129,846	85,214	11,774	16,200	58,248	5,707	15,004	15,148	13,000
Argo Oil	21	46,580	23,444	(214)	none	28,785	4,841	4,400	5,546	4,500
Ashland O & R	34	203,846	86,680	49,012	29,935	117,534	15,496	25,004	22,552	—
Atlantic	87	976,191	544,539	102,302	182,000	483,458	51,629	117,100	120,294	—
Aztec O & G	4	15,601	11,751	1,104	5,725	10,185	658	—	1,813	—
Bishop	31	12,493	7,067	(161)	1,554	5,516	752	2,557	941	—
British American	51	447,232	272,955	77,996	58,616	314,034	32,681	62,277	94,894	147,000
Champlin O & R	—	170,812	82,386	14,231	34,891	64,773	9,112	18,389	17,495	15,000
Cities Service	48	1,327,946	760,645	344,786	480,146	615,930	80,666	117,011	179,283	—
Clark O & R	25	28,670	14,387	3,838	3,322	14,443	1,079	—	6,359	—
Colorado O & G	6	77,400	58,100	8,652	16,800	34,921	3,875	17,001	7,500	—
Continental	81	892,121	323,408	104,255	151,752	370,000	79,272	130,698	141,933	—
Cosden	21	51,766	34,309	6,743	8,084	32,552	2,920	5,953	16,765	15,000
Crescent	39	16,717	14,716	4,957	3,890	19,640	778	3,489	6,063	—
Delhi-Taylor	12	78,156	51,099	6,796	50,565	19,110	4,210	7,500	15,990	4,000
Douglas Calif.	28	8,708	3,990	2,507	1,546	6,289	672	1,000	1,000	—
Drilling & Exp.	29	28,360	13,559	3,299	none	16,346	2,315	4,585	5,725	—
Fifteen Oil	20	9,718	6,559	1,245	none	7,804	624	—	1,291	1,287
General American	21	105,858	54,557	6,046	none	66,968	7,183	1,875	13,511	—
General Crude	28	54,231	23,581	9,351	none	23,581	29,783	6,208	7,500	4,600
Getty	29	109,436	60,889	19,756	38,713	105,940	5,571	—	—	—
Gulf Oil	57	3,914,397	1,954,226	450,051	316,752	3,240,571	252,265	582,756	664,217	692,000
Hancock	35	32,583	15,925	18,332	none	56,918	2,589	7,966	8,276	7,565
Honolulu	48	134,578	65,843	17,247	1,122	82,285	7,341	15,568	14,847	13,100
Humble	41	2,141,524	1,270,358	76,571	26,084	1,338,096	124,196	263,997	290,891	—
Husky	19	26,413	17,004	7,580	13,199	13,014	2,218	7,256	2,678	—
Kerr-McGee	26	95,717	68,271	37,700	44,836	72,253	7,038	17,790	22,900	23,074
Leonard Refineries	22	—	12,979	7,954	5,412	15,172	1,548	—	1,885	—
Louisiana Ld. & Exp.	32	31,038	22,649	6,969	none	29,618	994	4,125	5,446	—
Midwest Oil	46	79,081	29,184	5,111	none	34,270	2,478	5,800	6,194	—
Monterey	7	108,609	82,517	4,971	32,800	50,292	8,707	4,700	4,750	4,450
Murphy Corp.	7	80,074	65,338	7,169	20,100	33,827	5,371	—	17,293	12,625
Ohio Oil	70	601,733	270,270	64,848	none	356,012	24,528	76,984	89,948	56,695[1]
Phillips	40	1,826,372	1,101,612	211,527	332,734	1,519,631	123,639	257,352	216,417	—
Plymouth	34	111,631	56,576	17,220	19,240	55,283	9,193	12,164	10,101	—
Pure Oil	44	651,341	334,590	118,313	90,485	364,375	28,122	58,000	57,000	50,000
Quaker State	27	30,266	14,013	9,418	none	24,865	2,049	2,047	1,796	—
Richfield	46	441,120	223,829	82,749	99,000	223,359	26,173	42,428	59,231	—
Seaboard	39	168,126	70,181	11,037	none	81,523	9,397	2,387	27,100	—
Shamrock O & G	29	93,902	63,056	10,615	29,325	44,126	4,199	9,738	16,373	—
Shell Oil	45	2,377,477	769,395	293,765	166,087	977,566	227,803	234,646	265,635	279,006
Signal O & G	35	159,307	86,295	11,332	17,225	96,055	7,779	27,600	16,600	20,500
Sinclair	42	1,480,616	974,547	303,027	340,561	962,350	108,971	180,341	157,463	161,000
Skelly Oil	38	367,064	261,078	65,663	5,658	325,145	33,576	43,966	55,647	—
Socony-Mobil	75	3,227,294	1,670,660	704,125	211,400	2,378,925	181,965	329,000	420,804	435,000
South Penn	68	122,165	20,181	27,226	none	52,110	4,986	6,354	5,382	—
Standard Calif.	79	2 798,508	1,537,534	297,224	82,283	1,858,900	148,996	361,100	410,679	—
Standard Ind.	69	3.090,677	1,791,592	414,250	271,600	2,012,000	163,703	372,716	420,684	470,000
Standard N. J.	76	8,279,707	4,999,810	1,760,564	642,604	5,755,611	449,036	1,082,804	1,376,965	1,380,000[4]
Standard Ohio	88	460,288	252,539	58,074	63,000	237,216	22,982	50,110	69,885	56,000
Sun Oil	57	796,737	435,512	128,083	47,331	521,024	53,717	114,700	132,800	120,000
Sunray Mid-Con.	38	738,942	381,913	88,668	55,973	420,861	44,229	65,917	68,400	60,000
Superior	37	272,059	181,522	29,175	91,527	119,170	40,014	—	28,771	—
Texas Co.	56	3,189,623	1,590,085	595,722	306,740	2,053,369	216,177	589,900	481,708	500,000
Texas Gulf	27	72,146	39,047	9,314	7,650	40,711	3,708	9,660	9,400	8,800
Texas Pacific C & O	69	92,884	54,003	6,619	none	60,622	5,071	8,920	9,186	—
Tidewater	79	1,035,093	592,905	78,193	245,573	387,241	62,916	193,891	140,231	—
TXL Oil	3	24,782	19,834	4,522	none	24,356	2,332	—	5,919	—
Union of Calif.	67	889,301	429,572	161,131	187,050	411,372	46,312	85,285	91,346	79,190
Union O & G of La.	63	83,348	44,004	4,507	12,500	36,011	3,646	10,926	14,427	9,335
Universal Consolidated	36	22,432	21,393	8,686	none	21,393	2,167	500	800	800
Utah Southern	37	3,198	2,153	1,571	none	3,724	340	—	—	—
White Eagle	38	29,639	15,170	2,868	9,853	9,623	2,924	3,626	6,358	4,600
Wilcox	40	15,065	5,757	2,844	none	10,015	477	1,263	1,263	1,000
Woodley	35	23,370	15,911	3,428	7,875	15,667	983	2,395	2,650	2,650
TOTALS	—	43,797,799	24,287,573	7,016,196	4,881,258	27,971,658	2,761,016	5,755,919	6,480,736	—

[1] Not including exploration expense.
[2] Fiscal years given in Table 1 footnotes.
[4] Including $130 million as Jersey's share of capital expenditures in non-consolidated companies in which company holds 50% ownership or less.
[5] Last fiscal year.
[6] Other assets included here.
[7] Many companies do not separate capital investment and exploration expenditures so these figures include both.

ing; work resourcefully at lowering costs and in upgrading products—with the view of increasing both physical and dollar volume of our business."

Nor is Texas Pacific Coal and Oil dismayed. The company "has encountered and endured 'periods of uncertainty' many times before. Our long-standing principles of operating well within our income, of trying to get our oil to the market at the greatest advantage to the company, and of seeking maximum return for every operating dollar will enable us to continue our position of stability."

Capital Expenditures

The most reassuring phase of the oil industry picture is the budget for capital expenditures in 1958.

Budgets are not only holding but are ahead of the all-time record of 1957. An unprecedented 34 companies released information on 1958 budgets. These include most of the large companies and many smaller ones. Budgets for capital and exploration expenditures for 1958 are 2½ percent higher than 1957 expenditures.

Capital budget estimates (A-23) are based on detailed budgets released by companies. The estimates are for all United States companies and cover both domestic and foreign operations.

They would probably be much higher than 1957 except for the large sums in many budgets in 1957 for foreign concessions — particularly those in Venezuela. For instance, Sunray Mid-Continent reported: "The budgeted 1958 capital expenditures will be about $59,000,000, somewhat less than last year. When considering the Venezuelan investment in connection with the 1957 total, however, the company's 1958 budgeted capital expenditures are approximately the same as in 1957."

Union Oil and Gas Corporation of Louisiana: "The increase (in 1957 expenditures) resulted principally from higher expenditures for prospective and proved oil and gas properties in Canada, Venezuela, and Bolivia and for the company's share of the cost of the new gas processing plant at Eunice, Louisiana."

Ohio Oil Company: "Our share of these (Venezuelan) concessions . . . called for the payment of almost $26,000,000. As a result, the company's capital expenditures were boosted to almost $65,000,000, more than $12,000,000 greater than the record high attained in 1956."

If we deduct Ohio Oil Company's payment for the Venezuelan concession, the 1958 budget for capital expenditures is higher than was spent last year.

Since concession payments to foreign governments are difficult to trace in the U. S. economy, it seems reasonable to say that capital expenditures in 1958 will mean more to those who construct oil and gas facilities, supply equipment, materials and services, than was the case in 1957.

There is also evidence that companies with lower budget plans may increase investment with expected business improvement.

Continental Oil Company: "The company's capital commitments budget for 1958 provides for outlays at a reduced rate in the early part of the year. However, capital expenditures will rise in later months unless it becomes apparent that we are facing a prolonged business recession."

No actual figures are released by Conoco but this statement reminds us that capital and exploration expenditure budgets were worked up at a time of general business doldrums.

Time lapse between capital expenditures and returns on the investment is seldom commented on, but it is long and delay is always costly. Says Cities Service Company: "New physical facilities, created by record capital expenditures in recent years, are beginning to develop large earning power. Benefits from such expenditures, in the nature of things, come gradually but increasingly over a period of years."

For example: "Capital outlays for development of offshore oil lands in the Gulf of Mexico are only now beginning to produce earnings. In Canada, expenditures for exploration and drilling have been large during the past several years. It now appears that for the year 1958, cash earnings from these operations will exceed expenditures for the first time."

Speaking of capital expenditures, Standard Oil Company (Ohio) reports that these "provide the measure of continued growth and preparation for the future. They represent investments to increase productive capacity and reserves of crude oil, to improve and diversify products, and to serve customers more effectively."

Many annual reports point out the vital need of using capital investment to hold or improve competitive positions. "These expenditures are being made to place the company in a strong competitive position in the industry," reports Tidewater, and adds: "The first step was replacement of obsolete refining facilities. The next phase, which is now underway, was expansion of transportation and marketing facilities."

Taxes

Taxes collected on sales were 10 percent higher this year but direct taxes were about 2 percent below the all-time high of 1956.

Quaker State Oil Refining provided a lucid and almost horrifying account of the tax picture.

"Combined direct and indirect taxes on our operations and products in 1957 reached a total of $8,451,862. This is equivalent to $5,733.96 for each employee; $1,340.29 for each stockholder; or $10.24 for each share of stock outstanding. The direct tax to the corporation totaled $2,585,936, and $5,865,926 represented taxes which we were required to collect from customers and remit to governmental agencies."

Dividends

Dividends increased during the year. There was a trend toward more stock dividends, which will doubtless find favor also in 1958. Petroleum companies need volumes of capital and have a tendency to grow their own.

Large cash requirements during the forthcoming period caused Monterey Oil Company's board to decide that "if any dividends are paid during this period, they will be paid in the form of stock rather than in cash. The directors are confident that this policy will result in greater ultimate benefits to the shareholders."

Gulf Oil explains that, although it pays cash dividends at the same rate, the effect of periodic stock dividends raises the amount received in cash by those who retain their stock.

Financial Structure

During the year of 1957, the companies in our survey added some $3.7 billion to their gross fixed assets (Table 2) or 9 percent above 1956. Net fixed assets rose $3.4 billion.

Working capital increased by more than $250 million to top $7 billion for the first time. Long term debt totals expanded to nearly $5 billion. The rise of $375 million is lower than might be expected.

Net worth, or stockholders equity as some companies call it, advanced about $3 billion to reach $28 billion.

This shows a further decrease in rate of return on net worth. Here are the last seven years—the first five from Petroleum Facts and Figures* and the last three from our survey.

Rate of return on net capital employed

1950	15.5%
1951	16.8%
1952	14.6%
1953	14.5%
1954	13.0%
1955	13.0%
1956	12.7%
1957	12.3%

Profit on revenues went up slightly, as a result of price rises early in the year which eased during the last half. Percentage of earnings to revenues were 9.9 percent in 1957 compared to 9.4 percent in 1956.

*Published by API. These figures were compiled by Economics Department, Atlantic Refining Company.

Production Reaches New High

Annual reports are current operational history as well as a record of financial standing. The year's activity, their results and plans for the future are compressed within these reports. Here briefly are some comments on operations.

Exploration

Many companies are scheduling more exploration drilling this year in proportion to development drilling. The reason stated by Texas Gulf Producing: "Under these circumstances (lack of increase in demand) we will continue to concentrate our capital and efforts on exploratory drilling, as the drilling of excessive development wells would only contribute to the present overproduction from which our industry is suffering."

Woodley Petroleum has the same approach: "Present imbalance of supply and demand dictates, as policy, reduced development drilling and more attention to property acquisition and wildcat or exploratory drilling this year."

In 1957 TXL Corporation had 15 net wildcats compared to 7 in 1956. "This increase in the rate of exploratory drilling, which we expect to continue, reflects the results of our aggressive geological and geophysical program, which has steadily gained momentum since its beginning in 1955."

States Wilcox Oil, an integrated company, "in 1958 we plan to continue our vigorous exploration program."

Plymouth Oil's policy of geographical diversification leads its program into wildcat drilling to build reserves outside of Texas.

The older company, Clark Oil and Refining, entered exploration for the first time, opening an office in Denver. It expects to begin its drilling program this year.

Texas Pacific Coal & Oil points out a fact seldom mentioned — that exploration itself means long-time investment and diligent study. It explains: "It has always been our policy to maintain a substantial backlog of geological and geophysical data, keeping interpretation and evaluation ahead of our actual drilling programs. This procedure has helped to keep our discovery rate well above the industry average. Many exploratory wells are the result of surveys, studies, land acquisitions, and other procedures stretching over a period of 5 to 10 years after the prospect is initiated."

Exploratory costs come in for considerable discussion. States Argo Oil: "An increasing number of exploratory wells are being drilled in remote areas where the rugged terrain offers considerable hazards which require greater expenditures for exploration and drilling."

Murphy Corporation was one of several to state that its net income decline was due largely from an increase in exploration costs. These higher "exploratory costs are part and parcel of operations offshore and in foreign areas; so far, oil and gas discoveries in both areas appear to justify the expenditures, but the magnitude of risk will require constant reappraisal of the programs."

Each year Humble gives a review of its drilling costs. Average cost per well was $170,600 in 1957 compared to $131,600 in 1956. Reasons include: More offshore wells, rise in ratio of wildcats to total wells drilled, increase in depth (from 6947 to 7062 ft), higher costs of labor and materials.

There are gains from exploration certainly. Richfield reported finding the first commercial oil well in Alaska. In the Kenai Basin, it rated 900 bbl per day of 30 API gravity — a prize worth some exploration even though it may be many years before marketing is feasible and a pipeline outlet economic.

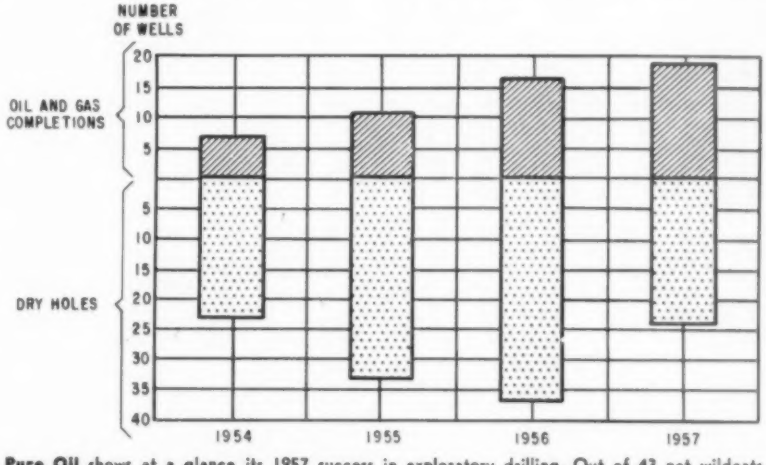
General American, which has held a Spanish concession since 1952, had new expectations: "Hydrocarbons have finally been encountered in two wells in the south of Spain. One showing was non-commercial, but in a well still drilling at Almarchal, numerous zones saturated with gas have been penetrated. Whether these deposits are commercial remains to be seen."

Production

Companies in the survey produced more than 8 million bbl a day here and abroad. This was 10 percent more than 1956, which was 9 percent higher than 1955.

Some companies hardly knew whether to boast of new production properties or not. As Superior Oil Company commented: "Enthusiasm for the successes of the past year must be tempered by the knowledge that worldwide supply of crude exceeds demand and the actual increase in demand has fallen short of expectations. Pay-out of producing properties is taking longer each year, creating a greater demand for capital."

Not only a longer time but higher costs are evident. Figures on per barrel costs are revealed by Texas Pacific: "Net result of these cost increases is an inevitable increase in our average cost of producing a barrel of oil. In 1957, the average was 66.7 cents compared with 61 cents at year-end, 1956.



Pure Oil shows at a glance its 1957 success in exploratory drilling. Out of 43 net wildcats 19 were oil or gas completions. Ratio was 44%.

- **Oil & LP Production Up 3%**
- **Natural Gas Production Up 11%**
- **Crude Runs Down 1%**
- **Discoveries 1 for 3.6 WC**

1957 Compared with 1956

TABLE 3. OIL AND GAS OPERATIONS — 1957.

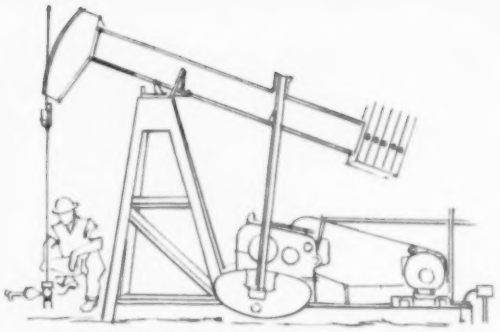
Company	Net lease or fee dev. or undev., 1000 acres	Net wells drilled 1957	Net producers Oil	Net producers Gas	Wildcats, net	Discoveries, net	Net producing wells owned	Net Production Crude oil b/d[5]	Net Production LPG b/d[5]	Net Production Gas MM cf/d[5]	Refineries Owned Crude oil capacity b/d[5]	Refineries Owned Crude runs b/d[5]	Estimated Reserves Oil million bbl.	Estimated Reserves Gas, billion cu ft
*Amerada	—	252[3]	—	—	—	—	3,365	88,031	—	—	none	—	—	—
American Petrofina	575	—	—	—	28	—	733	6,978[5]	—	21	30,000	21,641	28	130
†Anderson-Prichard	714	101	68	5	24	5	1,074	13,813[5]	—	41	37,500	29,526	—	—
Argo Oil	732	—	36	8	36	7	340	13,441	—	—	none	—	90	160
*Ashland O & R	—	73	38	—	21	3	—	8,676	—	—	165,500	137,082	11	—
†Atlantic	10,389	299	179	46	68	23	4,723	115,657[5]	—	506	210,000	199,642	591	3,521
Aztec O & G	186	25	13	12	—	—	264	1,098	—	41	none	—	18	775
†Bishop	67	11	10	—	—	—	313	2,391	—	0	none	—	8	—
†British American	13,438	513	331	29	144	30	3,888	62,825	—	31	145,500	110,000	432	3,600
Champlin O & R	1,362	122	63	16	47	15	1,460	22,800[5]	—	260	30,000	25,933	56	1,520
†Cities Service	6,643	579	452	61	97	29	—	122,271	—	837	288,000	267,000	—	—
Clark O & R	25	—	—	—	—	—	—	—	—	—	30,000	26,628	—	—
*Colorado O & G	1,387	55	25	6	18	7	1,104	7,310	—	55	20,000	16,980	—	—
*Continental	7,814	511	362	31	83	23	—	149,679	11,219	373	149,000	147,056	—	—
Cosden	121	79	66	—	—	—	324	4,091	—	5	50,000	33,272	23	—
†Crescent	449	4	3‡	—	—	—	290	3,000	—	—	none	—	5	178
*Delhi-Taylor	2,902	37	22	9	12	8	—	5,652[5]	—	101	55,000	32,956	18	2,250
*Douglas Calif.	—	—	—	—	—	—	—	1,458	—	—	—	17,253	2	—
*Drilling & Exp.	—	—	—	—	—	—	—	3,558	194	11	none	—	11	20
Fifteen Oil	252	8	7	1	½	½	102	2,290	—	3	none	—	—	—
†General American	821	—	—	—	—	—	2,964	23,385	—	—	none	—	109	224
General Crude	1,049	88	18	3	63	3	456	10,690	—	8	none	—	—	—
*Getty	418[1]	56	49	—	—	—	656	51,456	—	—	—	—	—	—
†Gulf Oil	—	2094	—	—	—	—	—	1,117,300	34,138	897	544,000	682,215	16,287	8,670
Hancock	283	45	23	—	—	—	252	—	—	—	18,900	17,964	—	—
Honolulu	3,036	86	64	3	23	4	1,461	36,239	2,819	66	none	—	—	—
Humble	16,250	857	648‡	—	—	—	13,457	360,600	—	1119	282,000	234,501	3,000	18,000
†Husky	362	—	—	—	—	—	175	5,551	—	—	6,500	6,053	—	—
*Kerr-McGee	1,641	52	29	13	5	—	618	5,855[5]	—	108	44,500	35,190	17	903
Leonard Refineries	—	—	—	—	—	—	—	—	—	—	—	25,610	—	—
Louisiana Ld & Exp.	702	12	10	1	2	1	88	21,231	—	36	none	—	—	—
†Midwest Oil	711	66	40‡	—	23	9	877	16,254	—	38	none	—	—	—
Monterey	230	46	37	1	9	2	671	14,186	7,991	11	none	—	64	55
Murphy Corp.	1,257	93	66	4	21	2	356	8,400	1,055	40	none	—	—	—
†Ohio Oil	52,907	—	—	—	—	—	—	95,561	11,064	290	42,000	41,521	645	2,270
*Phillips	—	319[1]	232[1]	32[1]	40[1]	16[1]	8,386[1]	132,007[1]	87,757[1]	2576	258,500	237,753	1,400	17,700
*Plymouth	—	104[3]	67[3]	11[3]	—	—	1,303[3]	17,932	—	91	—	41,101	90	800
†Pure	10,659	182	108	17	43	19	5,592	65,825	4,679	257	182,300	157,805	460	3,750
Quaker State	—	109	109	—	—	—	—	1,909	—	—	7,500	7,287	—	—
†Richfield	3,658	112	60‡	1	—	—	1,336	65,534	—	—	129,500	119,389	—	—
†Seaboard	—	—	127	94‡	38	8	1,379	40,290	2,973	102	none	—	205	700
Shamrock	608	104	63	12	41	—	—	6,679	8,386	194	—	17,870	85	1,700
†Shell	14,966	—	—	—	—	—	—	318,000	34,000	1029	584,000	506,000	1,500	—
*Signal O & G	538	65	48‡	—	—	—	1,247	44,400	10,529	84	none	—	150	200
*Sinclair	10,244[2]	529	447	43	108	23	—	129,539[2]	16,542[2]	369	488,000	442,986	800	2,800
Skelly	5,520	464	326	52	65	16	5,088	69,007	20,464	353	—	49,028	—	—
*Socony Mobil	11,074[4]	842[1]	660[1]	81[1]	77[1]	10[1]	16,292[4]	689,000[3]	28,000[1]	1007[1]	813,500	841,000	8,580	10,219
South Penn	769	304	—	—	6	3	13,269	11,355	—	—	12,000	10,011	43	51
*Standard Calif.	135,994[6]	968	760	32	120	31	9,568[7]	436,732[3,7]	18,313[3,7]	540[3,7]	585,000[7]	518,580[7]	—	—
*Standard Ind.	26,344[10]	841	502	122	195	59	12,807	425,400[8]	—	1298	714,000	648,076	2,174	12,720
*Standard N. J.	—	—	—	—	—	—	—	2,069,000	—	—	—	2,427,000	20,520	24,000
*Standard Ohio	2,657	70	37	6	23	6	2,160	36,487	3,401	101	139,500	110,744	93	645
†Sun Oil	19,594	420	268	99	167	77	—	121,302[8]	—	559	270,000	251,668	723	3,966
*Sunray Mid-Con.	7,000	326	186	43	82	17	5,205	81,646	5,857	363	120,000	108,556	—	—
*Superior	—	116	—	—	—	—	—	72,219	4,819	516	none	—	320	2,800
*Texas Co.	43,720	1528[11]	—	—	—	—	—	533,724	22,209	1012	536,000[1]	774,697	2,206	11,777
*Texas Gulf	—	37	28	—	—	—	—	13,900	—	43	none	—	150	600
*Texas Pacific C & O	1,760	99[1]	63[1]	10[1]	26[1]	7[1]	—	20,226	—	—	none	—	—	—
*Tidewater	2,704	200	176‡	—	25	13	5,873	93,476	13,589	228	247,500	202,527	604	3,081
TXL Oil	2,004	82	69	—	15	5	158	10,000	—	23	none	—	—	—
*Union Calif.	2,721	284	170	34	90	29	3,828	102,576	6,780	235	188,800	176,148	525	2,663
*Union O & G of La.	879	43	20	13	9	3	—	9,233	1,477	167	none	—	40	1,500
Universal Consol.	60	13	9	—	5	1	279	6,966	—	3	none	—	—	—
Utah Southern	—	13	—	—	8	—	—	3,939	—	2	none	—	—	—
*White Eagle	1,933	35	19	1	14	3	656	3,189	—	16	none	—	18	365
Wilcox	199	59	35‡	—	21	4	387	2,701	—	13	none	—	15	50
*Woodley	1,648	25	17	1	5	1	399	7,830	—	8	—	—	44	25
TOTALS	—	—	—	—	—	—	—	7,755,280	358,255	16,147	—	9,568,148	—	—

[1]U. S. only.
[2]U. S. and Canada only.
[3]Gross.
[4]Includes 1318 shut-in wells.
[5]Calendar day.
[6]Direct holdings and undeveloped.
[7]Western Hemisphere only.
[8]Includes LPG.
[9]Only full interest wells.
[10]Includes 89,000 acres royalty interest and 10½ million acres Canadian reservations.
*Has foreign operations.
‡(O&G).

1958 Budget Estimates

For U. S. Companies — Domestic and Foreign

Exploration	$2.3 Billion
Production	3.1 Billion
Transportation	.5 Billion
Manufacturing	1.1 Billion
Marketing	.8 Billion
Others	.2 Billion
TOTAL	$8.0 Billion



This and the sketch on the opposite page are from Sunray Mid-Continent's annual report.

This includes lifting expense of 30.3 cents; general field expense of 14.4 cents; gross production tax of 16.2 cents; and ad valorem taxes of 5.8 cents.

Those whose production was less last year than in 1956 explained the cut in allowables. Seaboard had virtually no change in production but its report carried the fact that Texas allowable producing days were reduced to a record low of 171 in 1957 compared with 190 in 1956.

Texas Gulf Producing indicated how this was done: "While the number of producing days in the state of Texas was 10 percent less than in 1956, our producing capacity increased about 13 percent, which enabled us to increase the number of barrels produced to a daily average of 13,900 for the past year, compared with 13,500 for 1956."

Louisiana Land and Exploration, despite state allowable cutbacks, showed that gains could be made. Its revenues and earnings increased 32 percent.

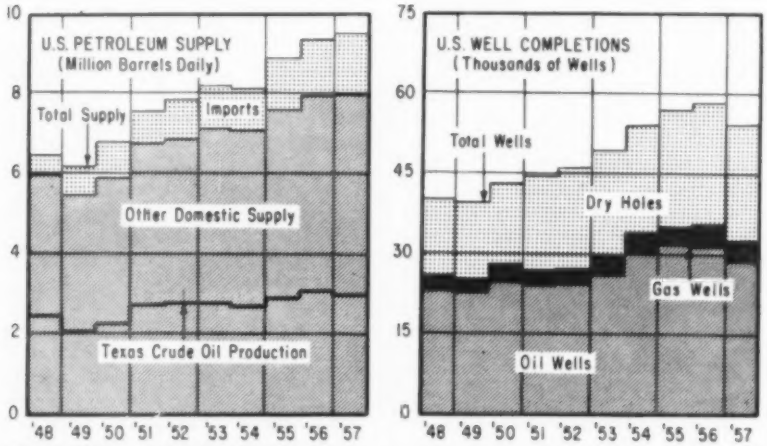
Secondary recovery projects got more attention than usual — probably because their production is not controlled by state regulatory bodies.

Skelly Oil report said "the importance of pressure maintenance and secondary recovery operations continues to increase. At present the company either operates or has joined with others in the operation of 64 such projects in 8 states. Approximately 9400 bbl per day, or 14 percent of our net production, is from these projects."

White Eagle Oil Company now has a staff of engineers engaged in secondary recovery operations. It reports "12 water-flood projects are underway in Illinois, Kansas, Oklahoma and Texas. During 1957 five new floods were commenced, three on depleted company leases and two on leases acquired for flooding purposes."

Here is a brief resume of the big program of Sunray Mid-Continent from that company's report: "Engineering and operating personnel at all levels are participating in a stepped-up campaign to find new ways, better practices, and improved equipment to produce more oil at less cost. Increased costs of labor, material and services have made such a program of great importance. Some of the steps being taken to increase efficiency include: (1) A program to eliminate marginal leases; (2) the application of automation to lease and gas plant operations; (3) increased attention to the use of testing equipment; (4) improved cost records, (5) reduction of paper work, and more effective use of manpower by means of increased application of electronic methods to data gathering and computations, and (6) exercise of better corrosion control in the operation of field equipment."

The zeal to improve production has been kept at high speed despite lag in markets. It would be virtually impossible to estimate the value of this determined effort to the consumer and to the industry.



Humble Oil and Refining Company's annual report presented a quick picture of U. S. oil supply and well completions.

Diversification and Foreign Operations

Oil companies haven't changed like the drug stores — they are still overwhelmingly producers and processors of hydrocarbons — but they are looking over other businesses.

Uranium has long been an appealing proposition for energy dealers. Some prospect for the ore; others in the industry process it. Getty Oil, with its aircraft, realty, insurance, and hotel companies, is a large example of diversified interests.

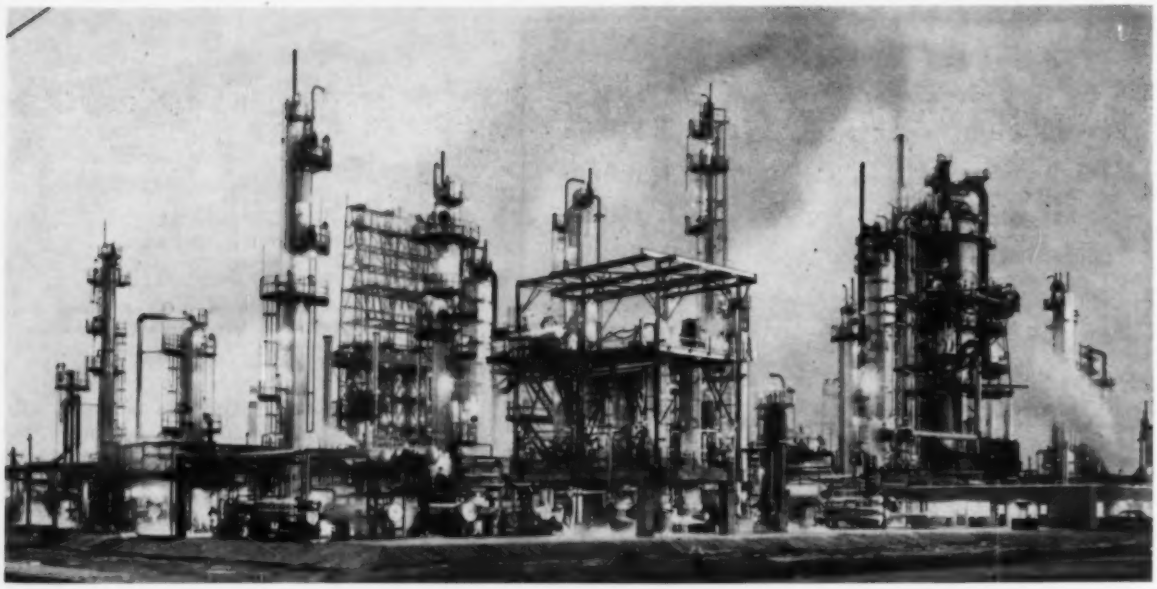
Other minerals — Delhi-Taylor explores for potash—are included among projects of several companies.

Signal Oil and Gas, which acquired American President Lines earlier, in 1957 acquired two food products firms.

In one way the entry of nearly every company in this survey into foreign operations is another form of diversification. This spreads risk over a wider area instead of over more kinds of business.

Signal, for instance, is also diversified in area. Although a small company, it has concessions in Venezuela, Guatemala, and the Middle East, and belongs to the Iranian Oil Consortium.

Champlin Oil and Refining acquired an interest in a concession in Panama last year and established an office in Canada.



Standard Oil (Indiana) showed this view of a modern refinery opened last spring. Operated by American Oil Company, a subsidiary, the plant at Yorktown includes crude distillation, catalytic cracking, polymerization, and treating in single combination unit.

Refiners Plan for Asphalt Market

There's greater stress on asphalt in the products picture for 1958. Reports Douglas Oil of California: "Estimates of expenditures for the next 13 years under the tremendous Federal highway expansion program, including contributions from state and local governments, total $100,000,000,000. Effects of this program have not yet been felt in the asphalt industry." Already successful in its asphalt division, the company goes on to say "Douglas Oil stands to benefit from this unprecedented expansion of road-building activity in four distinct ways: As a supplier of asphalt for new construction and surfacing; as a supplier of fuels and lubricants to road contractors; as a supplier of materials for surface and shoulder maintenance, and in the sale of motor fuels through strategically located modern service stations."

Husky Oil does a little drum beating for asphalt: "The Federal highway program will assist materially in producing an active and expanding market for asphalt in the years immediately ahead, asphalt construction offering, as it does, lower costs and therefore more miles of finished modern highway for highway budget dollars expended."

Asphalts and road oils are an important phase of American Petrofina operations, both at its Texas and Kansas refineries.

Cities Service explains, "your company's position in the expanding asphalt market will be enhanced as the new Linden, New Jersey, asphalt refinery begins operation in 1958."

Continental Oil Company reported: "Facilities for production of asphalt were installed during 1957 at the company's Artesia and Billings refineries. Production of asphalt totaled 111,172 barrels during the year and permitted a substantial upgrading in the value of residual stocks. In 1958 additional asphalt facilities are to be installed at Billings."

Kerr-McGee has "new asphalt truck terminal under construction at Omaha, Nebraska. Upon its completion, the company can deliver into customer tank trucks a full line of road oils and asphalts for distribution in the Nebraska, Iowa, and South Dakota territory."

Reflections of profit squeeze were seen in several reports. Plymouth Oil presented this detailed one which "graphically illustrates the current 'squeeze' on refinery profits as a result of higher crude costs and lower market prices of refined products:"

Month	Year	Avg./bbl. U. S. wholesale prices*	Avg./bbl. crude oil prices	Refiners' "spread" per bbl.
Jan.	1957	$4.24	$3.13	$1.11
Feb.		4.36	3.17	1.19
Mar.		4.34	3.17	1.17
Apr.		4.34	3.17	1.17
May		4.33	3.17	1.16
June		4.27	3.17	1.10
July		4.22	3.16	1.06
Aug.		4.18	3.16	1.02
Sept.		4.18	3.16	1.02
Oct.		4.17	3.16	1.01
Nov.		4.13	3.16	.97
Dec.		4.13	3.16	.97
Jan.	1958	4.07	3.16	.91
Feb.		3.89	3.16	.73

*Includes motor gasoline, kerosine, light and heavy fuel oils.

Many companies report new refineries. Several mention underground storage facilities in connection with plants. Atlantic Refining stated that "during 1957, five new licensee units using Atlantic's Catforming process to produce high octane gasoline were completed and started operation in refineries in Finland, Ontario, Alberta, Venezuela, and Texas."

One of the most significant advancements in refinery operations planning is linear programming, according to Richfield: "A mathematical model, which simulates the entire operation of the refinery . . . is the key to an advanced technique for planning refinery operations . . . information is recorded

on punch cards and fed into an electronic computer which then 'plans' operating programs designed for maximum efficiency and economy. The new technique has been used successfully in working out operations programs covering periods of from three months to a year."

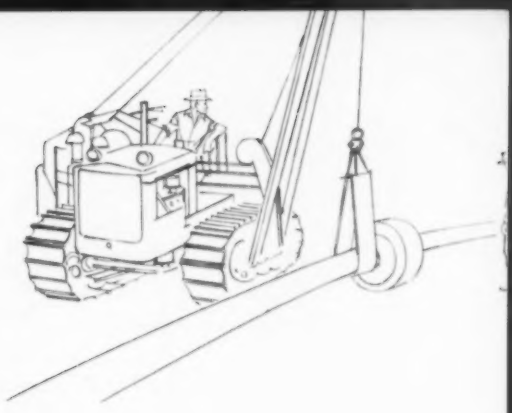
If you are wondering why continued refinery expansion in spite of present ample capacity, you'll find that in annual reports, too. For instance, Union of California closed down its Maltha refinery near Bakersfield because "it has become obsolete in view of today's high product standards . . . While our total refining capacity was reduced slightly by this move, our operating efficiency was increased by the removal of this obsolete facility."

Clark Oil and Refining reported, "the improved efficiency of the Chicago refinery, which will permit a much higher yield of high octane gasoline from a barrel of crude oil, should make it possible for the company to show an improvement in earnings."

So capital expenditures are holding up for manufacturing facilities. As Ohio Oil explains: "While a large part of the recent program has been concentrated on the production phase of our operations with increasing emphaas abroad, studies now in progress indicate that a major expansion in refining will be needed within the next two or three years."

Sun Oil reduces its plans to figures: "Capital expenditures in the Manufacturing Department in 1957 totaled $7,900,000, compared with $9,600,000 in 1956 and an anticipated $11,500,000 during 1958."

This and sketch on opposite page from Sunray Mid-Continent annual report



Transportation Improved

Volume of transportation remained high in 1957 despite last half slump. For instance, Shell pipeline throughputs increased five percent due "principally to the Suez situation."

One goal of pipeline construction — to effect greater economies—is of more importance in times of leveling off periods, when effort to promote efficiencies is stressed.

Expansion of Anderson-Pritchard's crude oil gathering lines, for instance, has kept pace with increased capacities at its two refineries, so the company can gather all the crude it processes. Comments the report: "A much more economical operation results."

About a CATC crude oil pipe from offshore, the Tidewater (one of group) report says: "The new line will reduce transportation costs and will permit an increase in production by eliminating losses previously experienced in allowed production due to inability of barges to move oil in periods of bad weather."

American Petrofina makes the same observation about products transportation: "To assist in the reduction of transportation costs, the company is making a substantial investment in a pipeline terminal and related facilities in the Dallas-Fort Worth area. This will permit economical transportation of gasoline through pipelines from our Wichita Falls refinery to this important market area."

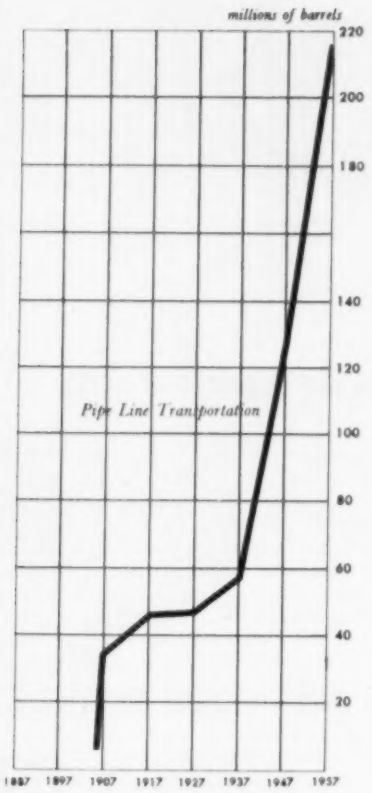
Gas transmission lines are getting their share of attention. Delhi-Taylor "owns 95 percent of the outstanding shares of Coastal Transmission Corporation which was formed for the purpose of constructing and operating a large diameter interstate natural gas pipeline from the Texas Rio Grande Valley to a point near Baton Rouge, Louisiana. There it will connect with the proposed Houston Texas Gas & Oil Corporation pipeline (owned 13 percent by Coastal) which will then deliver gas to the major consuming areas of Florida."

After reviewing its additions to pipeline and storage facilities, Pure Oil states: "We believe that for its size our company has one of the most extensive and economical systems for transporting crude and products in the industry."

Trends in pipeline transportation involve automation and a key item here is a communications system. As Atlantic Refining describes its addition: "To improve the reliability and efficiency of the communications between our Dallas, Texas, headquarters and the various terminals and pumping stations along our crude pipelines, the company completed the installation of a new 171-mile microwave system . . . This new installation has nearly doubled the capacity of our pipelines communication system."

The Ohio Oil graph on pipelines is indicative of the surging growth of this type transportation in recent years. The

Cities Service's report had this photo of a 30-in. pipeline which carries gas from the huge Hugoton field of western Oklahoma and Kansas to markets.



Ohio Oil which is celebrating its 70th year. This chart gives a dramatic illustration of pipeline expansion in one company.

present demand could not be supplied without the spreading arteries that feed energy to the nation.

The $500,000,000 capital expenditures slated for 1958 includes all types of transportation — pipe lines, tankers, tank cars and trucks — budgeted by U. S. companies for domestic and foreign operations.

Research

More than ever before our annual report companies are turning to research. The determination to improve its position in the industry pushes every company into the search for improved methods and better products at lower prices.

Shell Oil: "In this age of rapidly changing conditions, the value of research is more than ever apparent. Our organization is keenly conscious of this and very much alive to the need for development of new products, improvement in processes, and, most particularly, a constant looking ahead. The record of our research accomplishments is evidence of success in providing this necessary support to the overall effort."

Only a few provided separate figures for research but these were invariably growing except in cases like that of Gulf Oil where a major addition to facilities was completed in 1957.

The satisfying report that "about one fifth of the (research) money spent during 1957 was for basic research. Such research helps lay foundations in petroleum technology for the products and processes of tomorrow," was made by Jersey Standard.

Special projects were covered by many reports. Here are some samples:

Standard of California: "In the field of exploration, the complex device developed two years ago for evaluating seismic records electronically was significantly improved. The instrument lessens the time-consuming human activity that formerly made it impracticable to appraise such records."

Humble Oil and Refining: "Continuing efforts to reduce drilling costs resulted in the development and testing of improved equipment and techniques. A turbine-type drill made hole faster than conventional rock bits. Equipment for use with drill pipe and casing reduced pressure surges which cause formation damage and loss of drilling fluids. A drillstem tester with inflatable packer was used to obtain formation fluid samples and to test cored intervals without pulling drill pipe. A material was developed for sealing threaded casing that results in joints stronger and less expensive than those produced by field welding. A five-year development program on high-pressure wellhead and Christmas tree assemblies culminated with the delivery of several 15,000-lb working pressure units."

Skelly Oil Company: "The Skelgas Division maintains a research and testing laboratory in Kansas City to evaluate developments in the LP-gas industry and to improve the mechanics and design of Skelgas appliances and equipment."

Union Oil of California: "Major research emphasis was again placed upon the development of a commercially feasible process for extracting oil from oil shale. The experimental retort near Rifle, Colorado, was successfully operated under a wide variety of test conditions. Refining studies have proved conclusively that finished products derived from shale are indistinguishable from their natural petroleum counterparts."

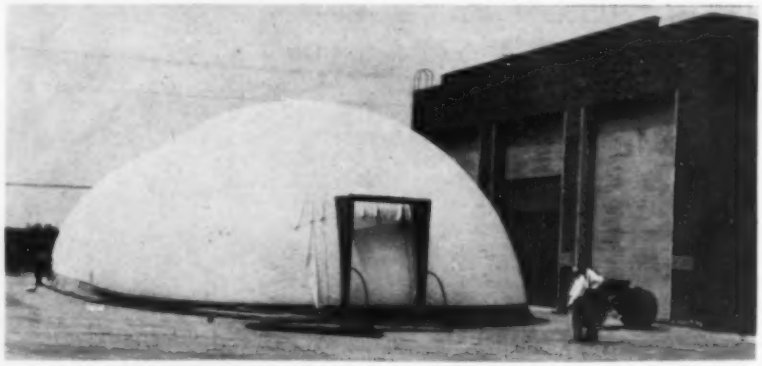
Husky Oil Company: "Husky has been actively exploring avenues for expansion and diversification in the petrochemical and related fields and in new processes or methods pertaining directly to the petroleum industry. One such undertaking was an agreement made with a Swedish firm in 1954 to field test, on asphalt sands, a process which that company is using successfully in recovering oil from the low-grade oil shales of Sweden."

Standard Oil (Ohio): "As a result of five years' research effort, Sohio has discovered new processes that may justify further diversification into the organic chemical field. We are now evaluating the commercial possibilities of these promising, low-cost processes. A pilot plant has been constructed for one of the projects, and detailed engineering studies are being made in order to confirm the economic feasibility of construction of a full-scale plant."

Reads another: "Quaker State has maintained a research organization for more than 25 years. The activities of the research laboratories are devoted to improved production and refining processes, product quality improvement and development of new products. In addition to the research activity conducted by the staff, specific research projects are authorized with outside research laboratories for 1958."

Legislation

Legislative matters are discussed less in annual reports than they have been for years. There are several reasons. The hope for more limited control for natural gas prices appeared rather dim when the 1957 annual reports were being written. This legislation has been a red flag too long.



Sohio pictured this innovation in storage facilities in its annual report. It is an air-supported warehouse that provides low-cost temporary storage. It can be erected by two men in two hours; when deflated can be stored in space about size of desk.

Shamrock Oil and Gas, however, reminds its stockholders: "The delays and uncertainties as to ultimate prices that independent producers may receive for gas produced and sold to interstate pipelines and the attendant time-consuming and expensive preparation for hearings in the city of Washington continue to emphasize the necessity for Congressional legislation to free arm's length independent gas sales contracts from Federal Power Commission control."

Crescent Corporation brings out the results of FPC control: "Natural gas is now the only fuel raw material whose price is controlled by the Federal Government — thanks to a weird decision by the United States Supreme Court. . . . The domestic natural gas industry continues to be a martyr to public utility regulation which is totally inapplicable to natural resources and which favors the development of foreign reserves at the expense of the U. S. producer."

Small but growing Fifteen Oil Company hasn't the problem yet but it warns: "Natural gas will be an increasingly important factor in the company's earning power. Thus far, all of its gas sales are on an intrastate basis, not subject to regulation by the Federal Power Commission, and it is hoped that corrective legislation will be passed before the company commences the sale of gas moving in interstate commerce."

Very few mention the Memphis case, which requires that utility customers consent before rates are increased. This means natural gas producers rate increases cannot be passed on until agreement is reached with the utility.

Pure Oil comments: "The uncertainty and confusion created by the U. S. Court of Appeals decision in the Memphis Gas Case emphasize the need for remedial legislation."

One company's reaction to FPC control of gas prices was to develop an industrial center in Texas. Phillips Petroleum gives the news on this project: *"New Industry Attracted to Gas-Producing States*—Through continued efforts to attract gas-consuming industries to gas-producing states, Phillips sold another of its Houston Ship Channel industrial sites to a purchaser which plans to build a large chemical plant there. Phillips will supply this plant with natural gas as well as ethylene from its Texas Gulf Coast properties."

Management is certainly concerned with growth of governmental regulations. Most companies will agree with General Crude Oil Company's appraisal: "Probably the most disturbing problem facing us today is the ever-increasing influence of the Federal Government in the field of regulating operations of private industry. Control of natural gas sales, repeated attacks on the 27½ percent depletion allowance and opinions expressed by various government representatives seem to indicate that the long-range objective is complete Federal control of all natural resources. It is expected that efforts in this direction will be intensified this year and it is imperative that we speak out in our defense and make a real effort to reverse this trend."

Imports

You get all views of imports from annual reports. Dangers from both extremes of the controversy are pointed out in Atlantic Refining's report:

"On one hand, we recognize that imports cannot be permitted to supplant domestic production; that unrestrained access of foreign crude to the American market could have drastic effects on domestic prices; and that ruination of domestic producers is certainly not in the public interest. On the other hand, we know that the addition of reserves to our domestic supplies is increasingly difficult and expensive. Clearly, excessive import restrictions could only result in the vicious circle of higher costs requiring more protection, and more protection causing higher costs, to the harm of the consumer and the detriment of consumption growth.

"We feel that the solution of the dilemma lies in temperance on the part of the domestic producer and restraint on the part of the importer in order that both may share in the predicted continuance of consumption growth. Furthermore, we believe the problem to be relatively temporary. Consequently, we have subscribed in principle to a flexible program of voluntary import restrictions."

One domestic integrated company, Anderson-Prichard, sees no hope in the voluntary import program and believes there are indications of a controlled import program.

"As a Nation, we certainly are not running out of oil but due to excessive imports we have been running out of a market," reads the message to stockholders. "When imports are brought under control we will again proceed with the active and rapid development of our own natural resources. In the interest of national security we have already done well by building up an excess productive capacity of more than three million barrels of crude oil per day, and with a fair economic climate our national security may easily be further fortified."

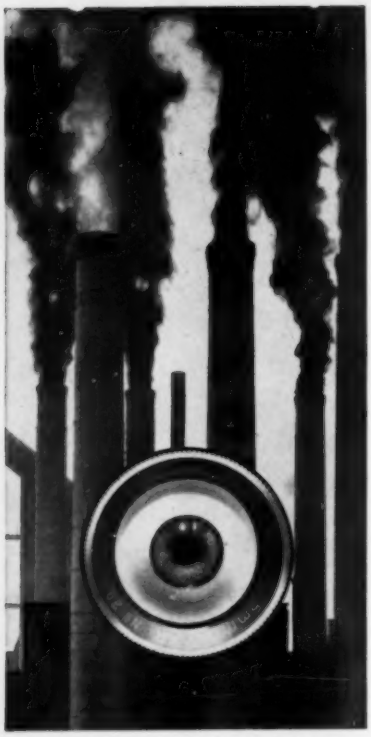
A producing company, Amerada, also points to national defense needs: "The events of last year, involving the closing of the Suez Canal and the interruption of pipeline transportation from some of the Middle Eastern oil fields, have proved beyond question that a strong and vigorous domestic oil industry is indispensable to our national security and defense, and that the country cannot afford to permit this industry to be weakened by excessive imports."

Cosden Petroleum's 200-ft towers in the styrene production unit. This is the first application in the world of ultrafractionation for recovery of ethyl-benzene from a xylene mixture.

After stating it had conformed to "suggested import quotas in the expectation that time will solve part of the problem, and wise handling the rest of it," Gulf Oil, an international company, added, "attitudes toward the import issue fluctuate between extremes according to the rate of growth in demand. At present, with demand lagging, the complications and reactions are accentuated; upon the resumption of a more vigorous growth trend, many of the current difficulties will diminish, if not disappear."

Sun Oil Company explained it did not agree to join other oil industry units in a voluntary restriction of imports.

"We feel such action definitely constitutes steps toward cartel arrangements that are forbidden by the Federal antitrust laws. We further believe such an agreement would be destruc-



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tive of basic competitive enterprise principles and of individual freedom and opportunity. Your company believes oil imports should be curtailed through the realistic imposition of appropriate tariffs that would apply to all importers."

Outlook

A few glimpses into annual reports show what management expects for 1958.

Jersey Standard: "The readjustment in the economy that is now going on does not alter our confidence in the longer range future. This is not the first time, nor will it be the last, when relatively short periods of consolidation follow years of rapid growth and lead on to further years of expansion. The rising level of population in the United States and in many areas abroad and the growing desire for higher living standards throughout the world promise a return of economic expansion."

Universal Consolidated Oil Company: "We are hopeful . . . if all of the importing companies will cooperate with governmental recommendations as to import quotas assigned to them, that through realistic adjustment the inventory and oversupply situation will be resolved in the not too distant future."

Sun Oil Company: "Your company . . . sees no need for any governmental action incompatible with sound American principles, lest efforts to stem what may be a comparatively short recession might intensify the inflationary flames that have seared this country for better than two decades."

White Eagle Oil Company: "We are striving to balance our emphasis between foreign and domestic operations, both in contract drilling and in exploration, in the firm belief that the oil industry's horizons will continue to broaden above a growing worldwide market for its products."

TXL Oil Corporation: "Although we are wholly optimistic for the long-term outlook, it is impossible to predict how soon we may be able to return to what oil men like to think of as "normal" conditions, with 16 or more producing days each month in Texas and a price for oil and gas that stays reasonably in step with the costs of doing business."

Woodley Petroleum Company: "Although the future of the oil industry may be clouded by circumstances, it is well for us to remember that the broadminded leadership in oil has brought us through many crises before. It is our confident prediction that this leadership will again succeed."

The Texas Company: "It is generally expected that an up-turn in business will occur during the latter part of 1958. . . . In the light of changing economic conditions, it is impossible to forecast consumption accurately either in the United States or the rest of the Free World. We believe, however, that it is reasonable to expect a rise of two percent to three percent in domestic, and five to six percent in foreign consumption."

Union Oil Company of California: "Outlook is for reduced profit margins and intensified competition in 1958."

Plymouth Oil Company: "The management of your company recognizes that the industry has passed through many other difficult and ominous times and that it has emerged from every crisis more virile than before. It has sought to retain flexibility by adapting the company's operations to existing conditions without elimination of long-range plans for expansion. . . . Timidity would be as great a folly as injudicious expansion."

Utah Southern Oil Company: "The future of the U. S. petroleum industry from a long-range viewpoint is bright."

Socony Mobil Oil Company: "Looking beyond the current decline in general business activity, we expect that demand for oil products will continue to increase throughout the Free World and that the rate of increase abroad will exceed that here at home. Although our economists expect the percentage of increase in the Free World during the next decade to be less than that in the past decade, the volume increase is estimated to be greater, as shown below:

Free World Petroleum Demand
(In barrels a day)

		10-Year Increase	
	Demand	*Percent*	*Volume*
1947	8.1 million	.....	.....
1957	15.9 million	96%	7.8 million
1967	24.8 million	56%	8.9 million

Early reports on the first quarter 1958 show the expected drop in revenues and sales. There was no doubt that this year's demand could not meet the abnormal demand brought about by the Suez Crisis. We'll have to wait until the results of the year of 1958 are in before making comparisons.

As one economist said, this is a good year to scrape the barnacles of inefficiency off the corporate ship of business.

Colorado Oil and Gas expresses the idea of showing income this way: "A substantial deferment of oil revenues developed both in the United States and Canada through severe proration of output per well by pipeline purchasers and governmental authorities."

It's a good thought to hold in mind — oil revenues are deferred, they haven't been lost. ★ ★ ★

"People in Petroleum", part of the annual report survey, will be published next month.

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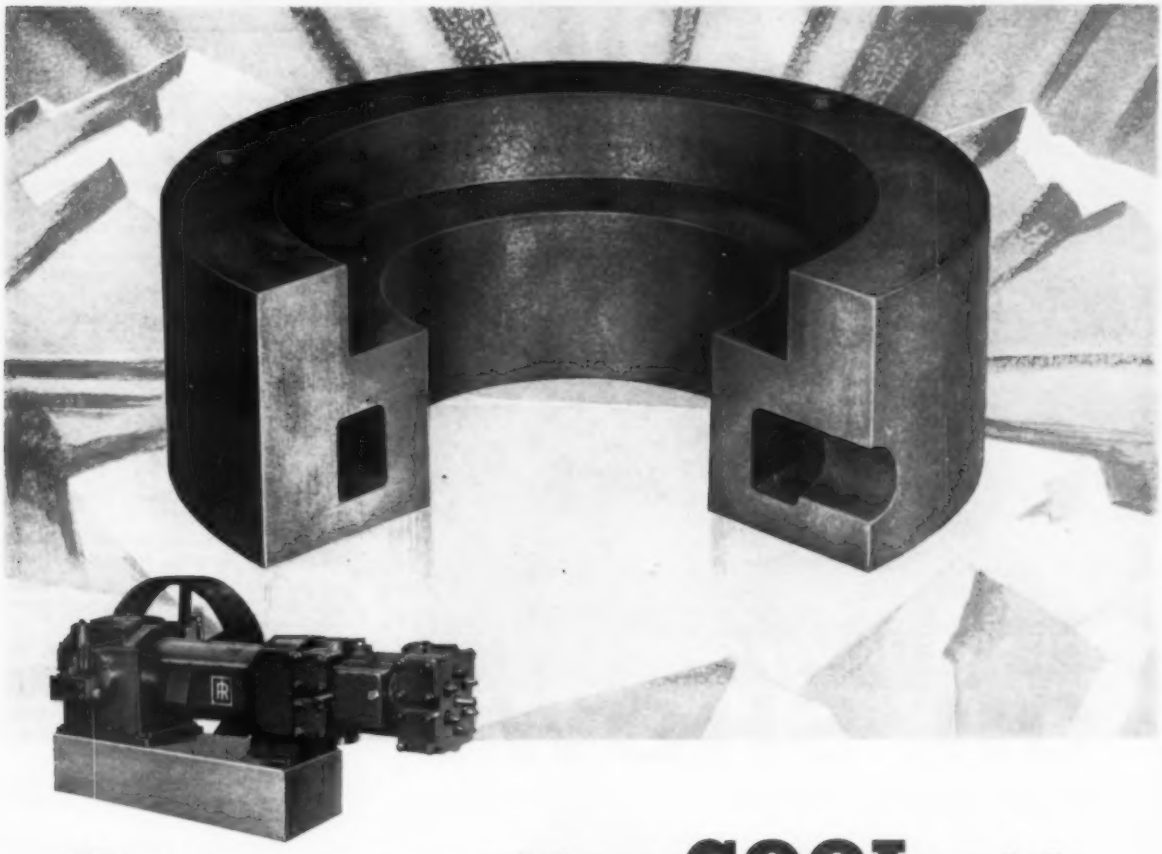

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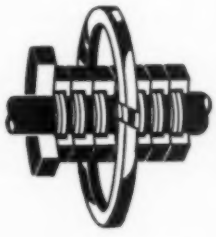

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Meetings

May 12-15—**ASME**, Oil and gas power conf. & exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa.

May 12-16—**API Division of Refining**, midyear meeting, Statler Hotel, Los Angeles, Calif.

May 19-23—**National Fire Protection Assn.**, 62nd annual, Palmer House, Chicago, Ill.

May 21-22—**WPRA**, southwest regional technical-industrial relations meeting, Hotel Paso del Norte, El Paso, Tex.

May 22-23—**API Division of Production**, Pacific Coast district meeting, Biltmore Hotel, Los Angeles, Calif.

May 25-29—**Air Pollution Control Association**, 51st annual, Sheraton Hotel, Philadelphia, Pa.

June 2-4—**Texas University Computer Conference**, Austin, Tex.

June 2-4—**Petroleum Electric Power Assn.**, Texas Hotel, Fort Worth, Tex.

June 2-7—**Seventh International Mechanical Engineering Congress**, Scheveningen, Neth.

June 2-7—**ASTM Committee E-14**, meeting on Mass Spectrometry, Jung Hotel, New Orleans, La.

June 8-13—**API Division of Production**, midyear committee conf., Hotel Deauville, Miami Beach, Fla.

June 9-13—**4th International Automation Exposition and Congress**, New York Coliseum, New York City.

June 10-12—**Appalachian Underground Corrosion short course**, West Virginia University, Morgantown, W. Va.

June 11-14—**National Society of Professional Engineers**, annual meet, Chase-Park Plaza hotels, St. Louis, Mo.

June 22-25—**American Institute of Chemical Engineers**, 50th anniversary meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 25-26—**WPRA**, Mid-Continent regional technical-industrial relations meeting, Broadview Hotel, Wichita, Kans.

June 28-July 2—**Petroleum Equipment Suppliers Assn.**, annual meeting, Chateau Frontenac, Quebec, Can.

Aug. 18-21—**ASME**, Heat Transfer-AIChE conf., Northwestern University, Evanston, Ill.

Aug. 25-27—**Appalachian Gas Measurement Short Course**, University of West Virginia, Morgantown, W. Va.

Sept. 9-12—**10th National Chemical Exposition**, Chicago section of the American Chemical Society, International Amphitheatre, Chicago, Ill.

Sept. 10-12—**Mid-Continent Oil & Gas Assn.**, Mississippi-Alabama annual, Buena Vista Hotel, Biloxi, Miss.

Sept. 15-19—**13th Annual Instrument-Automation Conf. & Exhibit**, Philadelphia, Pa.

Sept. 18-20—**Rocky Mountain Assn. of Geologists**, symposium of Pennsylvanian rocks, field trip of Paradox Basin, northwest and eastern Colorado.

Sept. 21-24—**ASME**, petroleum mechanical engineering conf., Cosmopolitan Hotel, Denver, Colorado.

Sept. 21-24—**American Institute of Chemical Engineers**, regional meeting, Hotel Utah, Salt Lake City, U.

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Sept. 24-25—**WPRA**, Rocky Mountain regional technical-industrial relations meet, Henning Hotel, Casper, Wyo.

Sept. 25-26—**Mid-Continent Oil & Gas Assn.**, Arkansas and Louisiana annual, Roosevelt Hotel, New Orleans, La.

Oct. 1-2—**WPRA**, 3rd annual stream pollution and waste disposal conf., Lassen Hotel, Wichita, Kans.

Oct. 1-3—**AAODC**, 18th annual, Adolphus and Baker hotels, Dallas, Tex.

Oct. 5-8—**Society of Petroleum Engineers of AIME**, fall meeting, Houston, Tex.

Oct. 7-8—**Texas Mid-Continent Oil & Gas Assn.**, 39th annual, Statler Hilton Hotel, Dallas, Tex.

Oct. 12-18—**Oil Progress Week**

Oct. 13-15—**AGA**, 40th annual conf., Traymore Hotel, Atlantic City, N. Y.

Oct. 13-16—**Society of Exploration Geophysicists**, annual meeting, Gunter Hotel, San Antonio, Tex.

Oct. 16-17—**AIME, Southern California Petroleum Section**, fall meeting, Biltmore Hotel, Los Angeles, Calif.

Oct. 16-19—**Permian Basin Oil Show**, Odessa, Tex.

Oct. 20-24—**NACE**, annual conf. & exhibition of South Central Region, Roosevelt Hotel, New Orleans, La.

Oct. 23-24—**WPRA**, El Dorado regional technical-industrial relations meet, Rufus Garrett Hotel, El Dorado, Ark.

Oct. 26-28—**Independent Petroleum Association of America**, annual meeting, Statler Hilton Hotel, Dallas, Tex.

Nov. 10-13—**API** 38th annual meet, Conrad Hilton Hotel & Palmer House, Chicago, Ill.

Nov. 30-Dec. 5—**ASME**, annual meet, Statler & Sheraton-McAlpin hotels, New York, N. Y.

Dec. 3-5—**API Oil Information Committee** meet, Waldorf-Astoria Hotel, New York City.

Dec. 7-10—**American Institute of Chemical Engineers**, annual meeting, Netherland Plaza Hotel, Cincinnati, O.

1959

May 30-June 6—**Fifth World Petroleum Congress**, Coliseum, New York City.

NOMADS MEETING DATES AND SECRETARIES

New York Chapter, first Monday of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 903, 45 Rockefeller Plaza, New York 20, N. Y.

Houston Chapter, second Monday, Ye Old College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18171, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Jonathan Club, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 3771, Tulsa 9, Okla.

Dallas-Fort Worth Chapter, first or second Monday, Secretary, R. B. Gilmore, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Texas.

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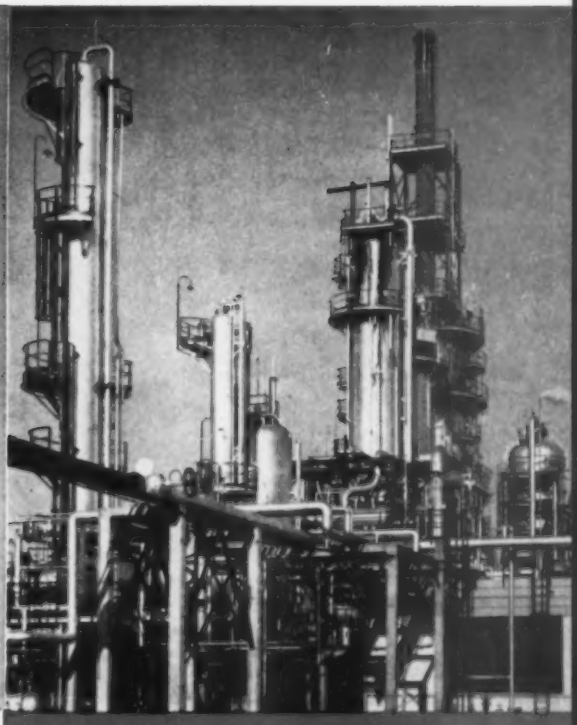

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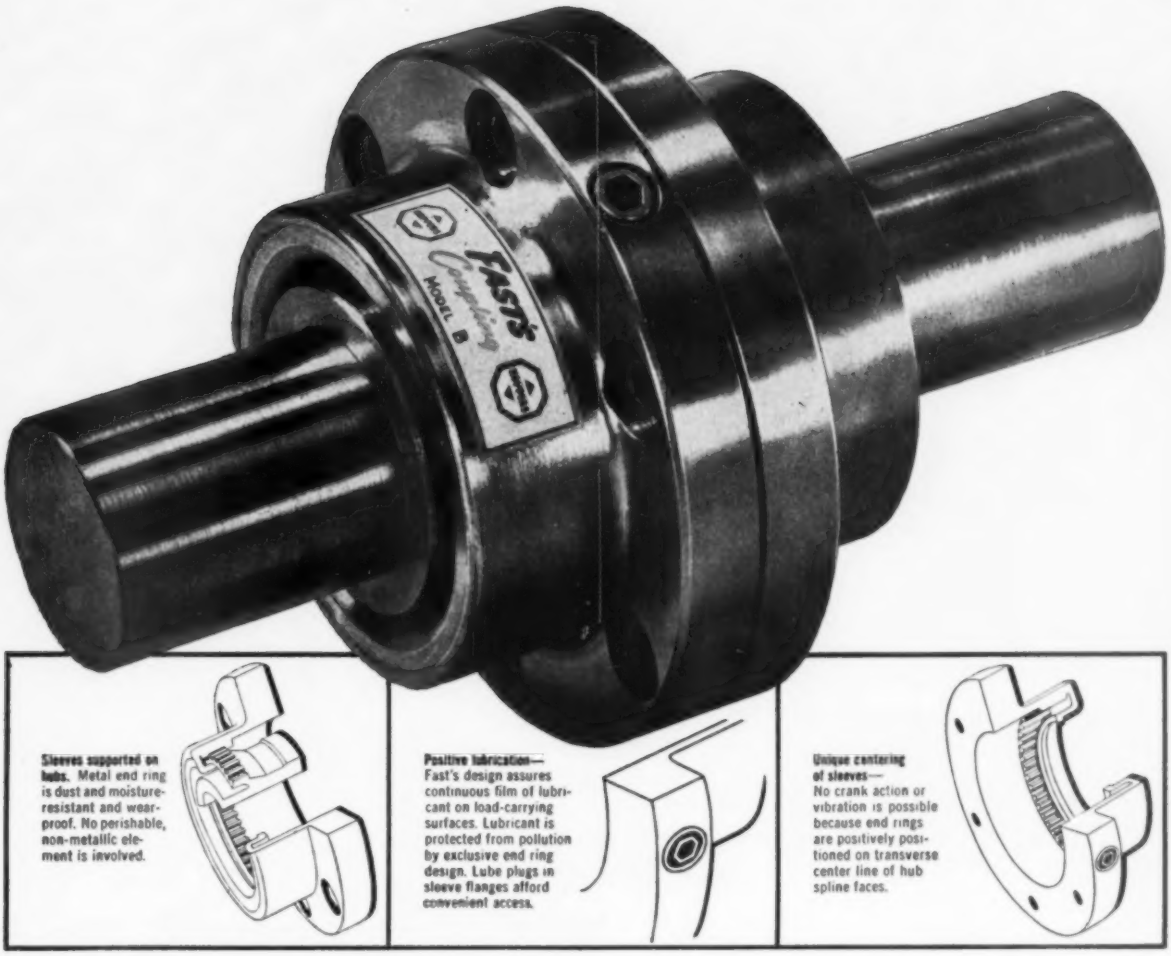

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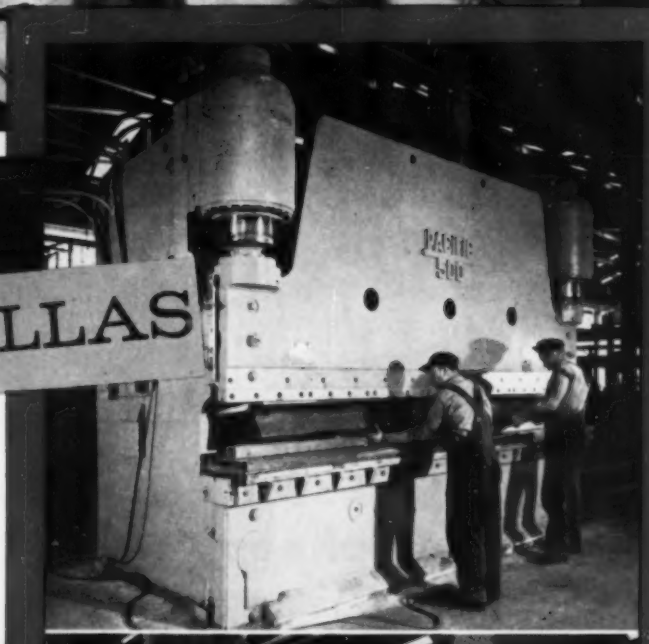

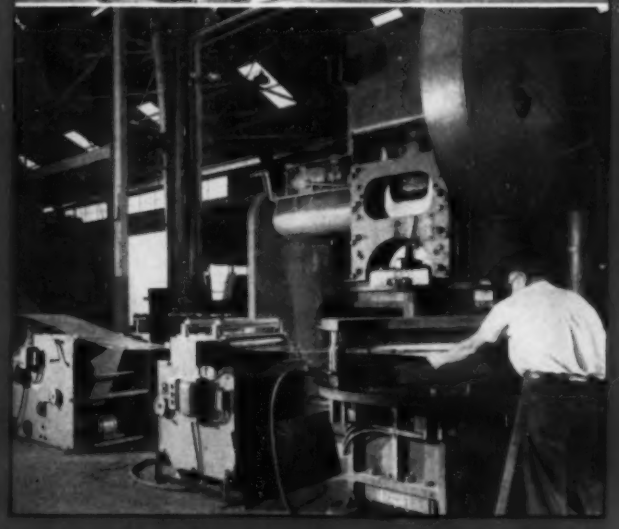

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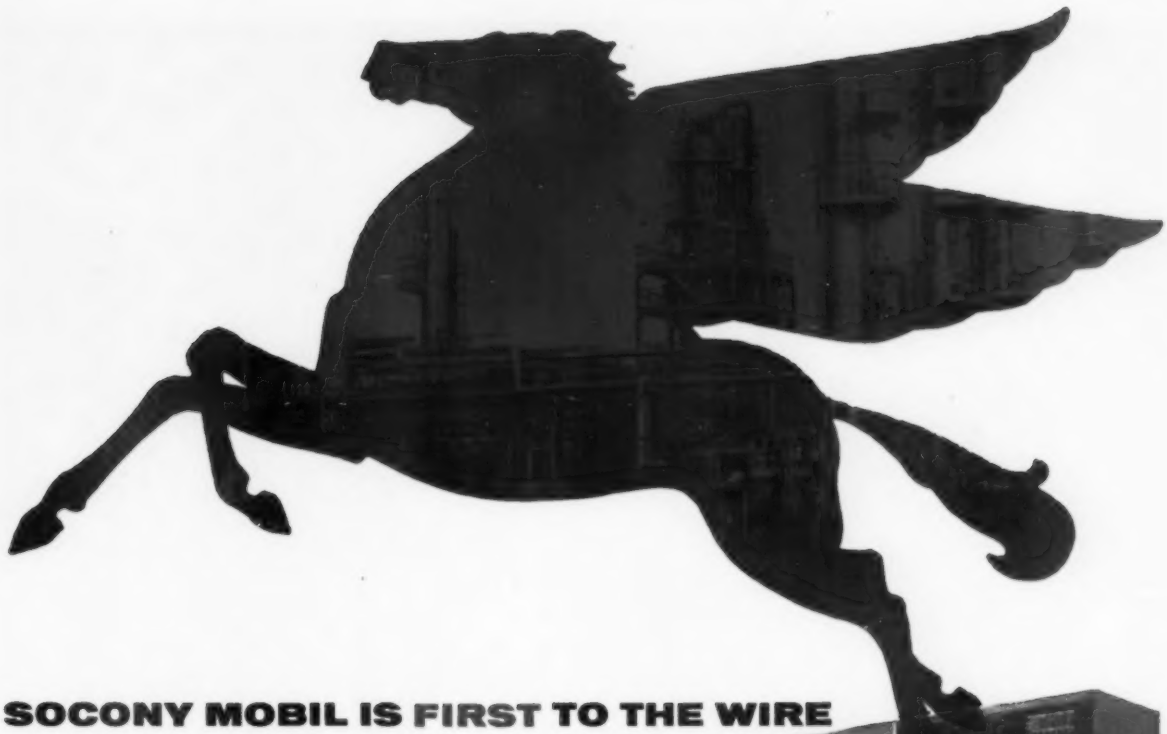

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Going on-stream to push out 3,000 barrels of hi-octane a day, Socony Mobil couldn't take chances with an untried instrumentation system. And yet, because they were investing in the future, they couldn't afford to put their money on the past.

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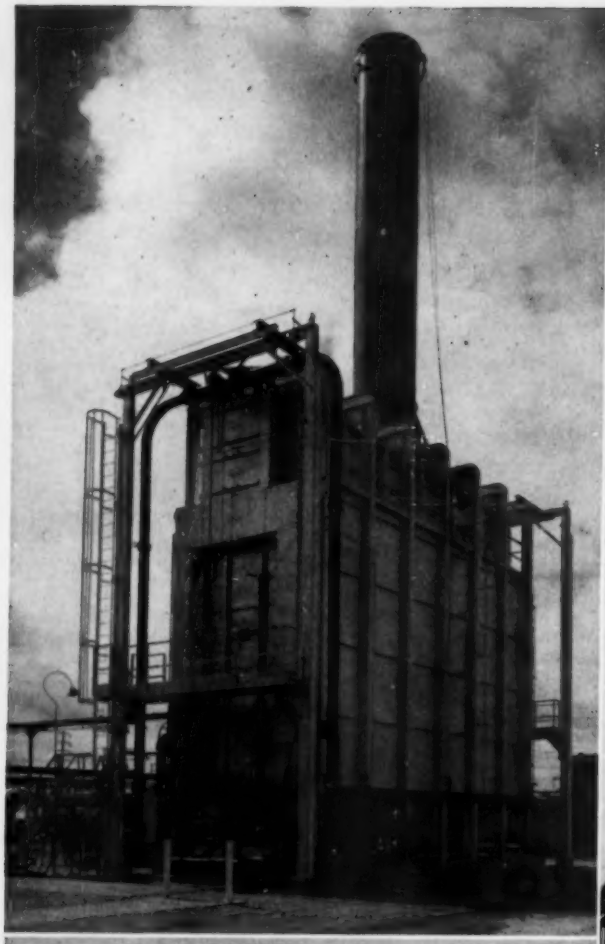

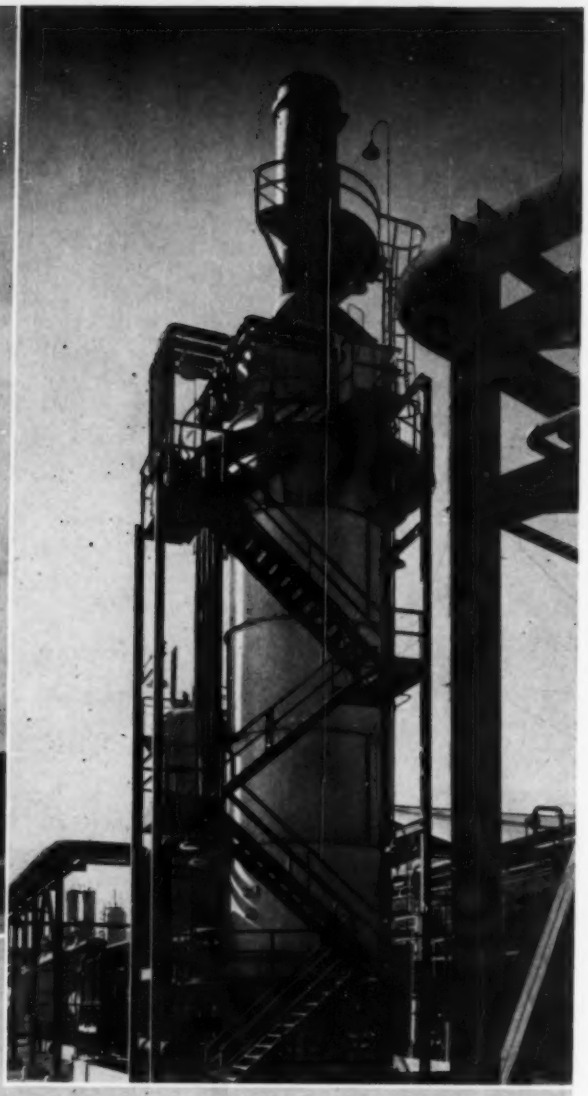

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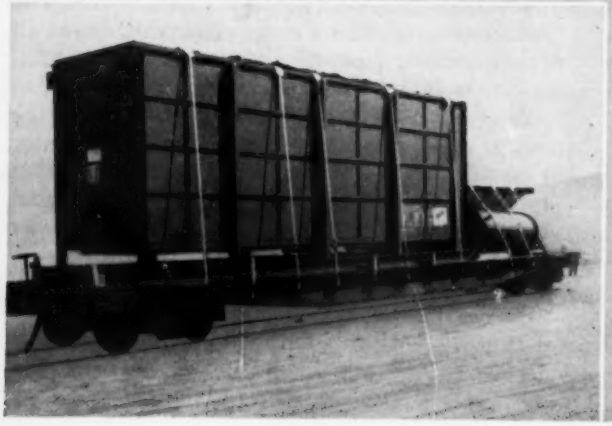

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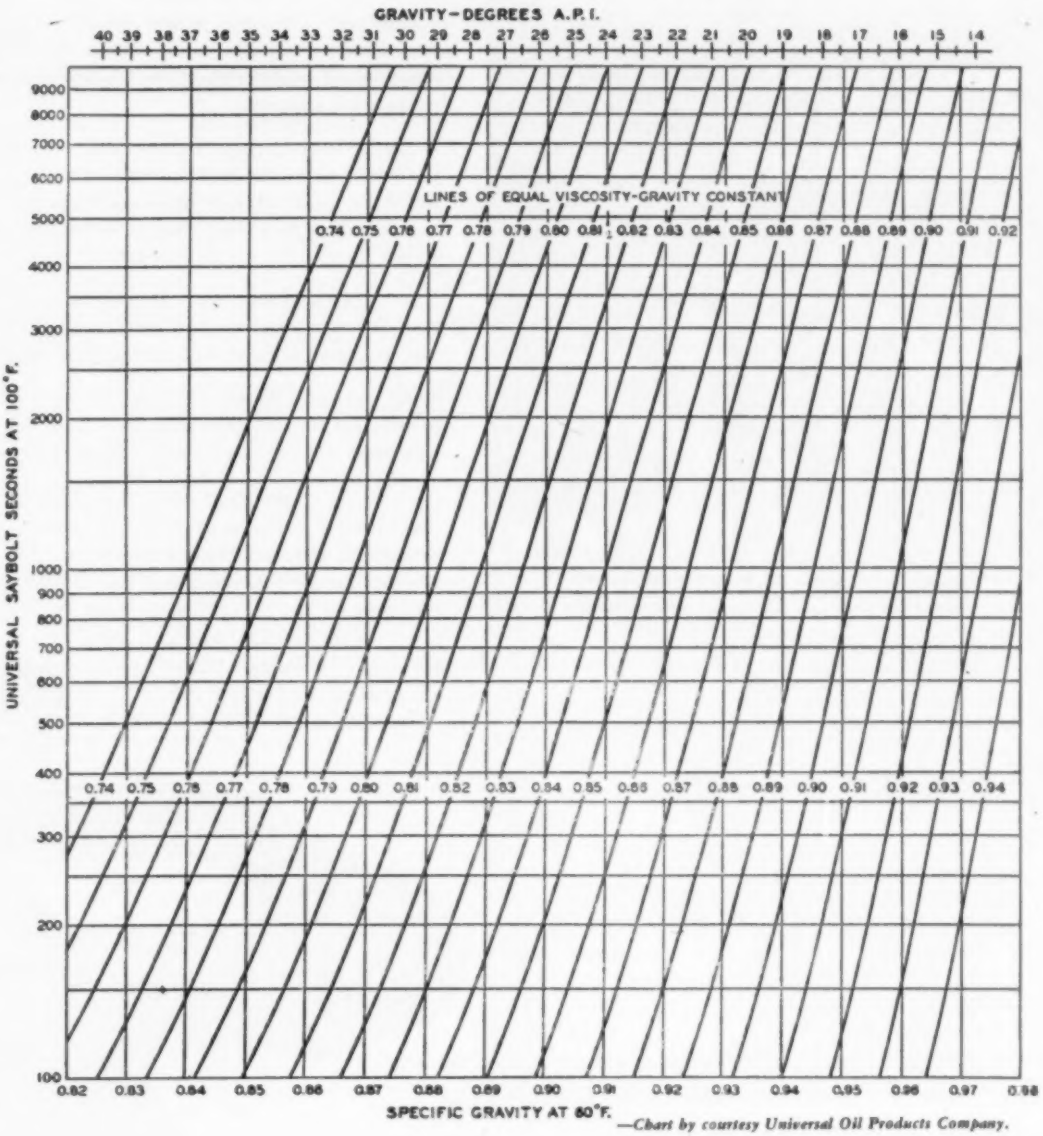
CHART FOR VISCOSITY - GRAVITY CONSTANT

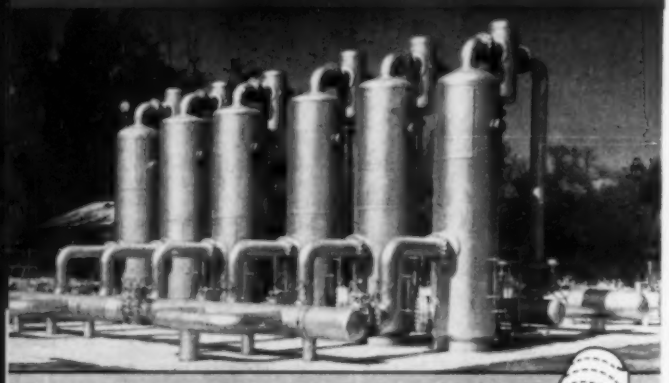


—Chart by courtesy Universal Oil Products Company.

The viscosity-gravity constant is an arbitrary numerical value calculated from the Saybolt viscosity and gravity. It is a classification denoting the paraffinicity or naphthenicity of an oil. The viscosity-gravity constant is "low" for paraffinic oils (0.8) and "high" (0.9) for naphthenic oils.

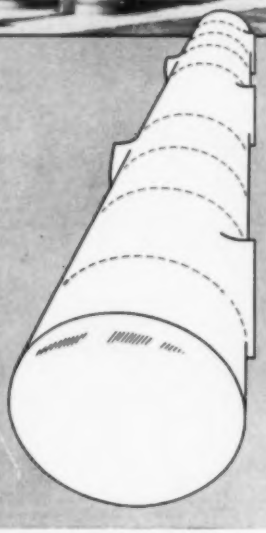
To obtain the viscosity-gravity constant by the use of the chart, locate the gravity along the bottom of the chart corresponding to the gravity of the sample. Align the viscosity obtained with the one along the left side of the chart. Find the point of intersection of the straight lines from these points. Take the diagonal line closest to this point and read its number. That number plus or minus the interpolated distance from or to the next line gives you the approximate viscosity-gravity constant.

How Oklahoma Natural compounded savings by specifying cold extrusion



Oklahoma Natural Gas Company compounded installation savings at their South River Station, Tulsa, by (1) designing for multiple outlet headers and, (2) specifying Fluor-formed headers with cold extruded outlets.

The diagram at the right shows how each of the four 20" O.D. headers at the South River Station eliminated five 20" × 20" × 12" reducing outlet tees and eight 20" welds (indicated by broken lines on diagram)—a total saving of 20 tees and 32 welds!



By specifying Fluor-formed headers with cold-extruded nozzle outlets, these added savings were realized

1. IMPROVED STRENGTH & DURABILITY — Polished extrusion dies impart a smooth, dense surface finish to the outlet—assurance of longer service life where vibration or pulsation stresses are involved.

2. CLOSER DIMENSIONAL TOLERANCES — Flowing steel under compression while in a tough stable condition permits extremely close tolerance dimensional configurations—center-to-center and centerline location tolerances are easily held within .060".

3. LESS MATERIAL NEEDED — Fluor-formed cold extruded multiple outlet headers need no extra length for manufacture—they are made to the exact length and wall thickness required.

4. NO DELAYS — Because nozzle outlets are cold extruded, headers are often made from stock or from the same pipe used elsewhere in a job—production is faster, inspection is simpler.

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HOW TO REDUCE COSTS

Key factors and basic rules for a successful cost reduction program . . .
Check list for setting up organization and keeping it on the move . . .

Benjamin P. Hamilton, Jr.

AS A RECENT STORY goes the Cost Reduction Committee in a plant of a major oil company voted to disband. As its last act the Committee accepted the resignations, from the company, of all committee members. These resignations reduced the plants payroll to nothing.

Among its cost reductions the committee had arranged for subcontracting all maintenance and repair work through the Home Office. All incoming shipments were machine weighed or metered and receipted using an automatic card punching and data transmitting system. The manufacturing process was fully automatic. Finished products were machine counted to a distributor. The plant had become fully automatic.

This story is not as improbable as it may seem. Few, if any, financial programs offer more to operating people or have a healthier impact on operating results than a well organized cost reduction program. In some companies aggressively promoted cost reduction drives have been major factors in cutting costs by 5 to 10 percent a year for several consecutive years.

The same results are possible in almost any oil company that establishes a sound cost reduction plan and follows through with aggressive company-wide action. If you are planning — or already operating — a cost reduction activity in your company, here are some organization and operating practices to help make it successful.

Top Management Backing

Key ingredient in effective cost reduction is full backing of top management. Be sure that top management is fully convinced that costs can be reduced. There should be no reservations, management-wise, about the desirability of the program.

Top management should not only endorse the program — top management, and especially the executive manager, should periodically back the cost reduction drive with talks and bulletins.

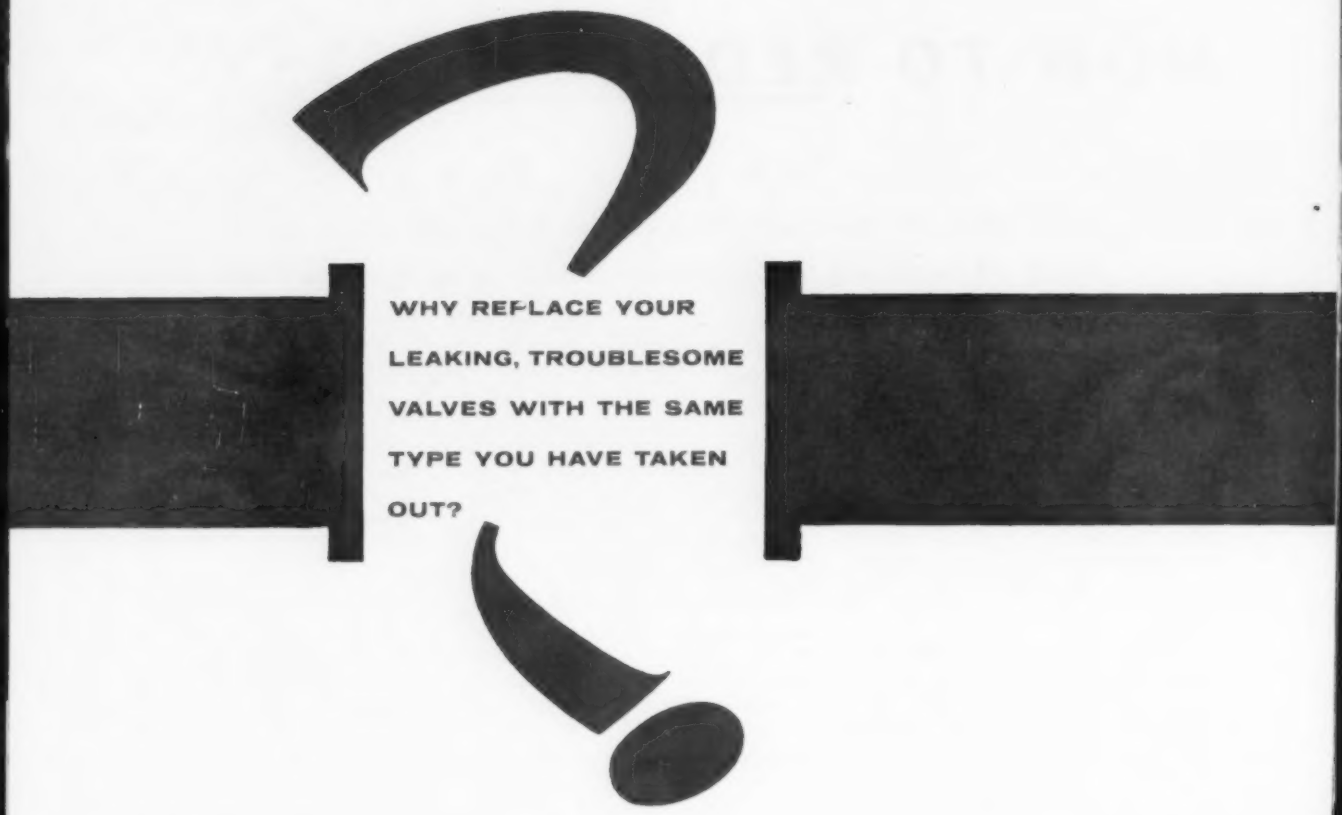
Like any management program the advantages of cost reduction need convincing and realistic explanation. One main advantage of the cost reduction approach is the psychological impact from targeting *improvements* in expenses. You can get much greater management interest in accomplishing a $10,000 cost reduction than in meeting a budget of $90,000 for an activity that cost $100,000 the year before. This is difference in emphasis. A savings of $5000 is only half of the cost reduction target but is within 5 percent of the budget. You may be satisfied to come within 5 percent of your budget

Check List of Cost Reduction Program

If you are planning or already operating a cost reduction program, check all of the following items to make sure that you are not missing any action that would make your program more effective:

1. **Organize a cost reduction committee under a permanent chairman.**
2. **Make sure that cost reduction representatives are appointed by each department and that each has time free for the work.**
3. **Prepare a brief manual of rules.**
4. **Keep the rules as simple and informal as possible.**
5. **Get top management backing.**
6. **Don't offset savings with increased expense for other items.**
7. **Have regular meetings of cost reduction representatives — at least bi-weekly.**
8. **Set stiff targets (5 to 10 percent of operating expenses).**
9. **Try "brainstorming" sessions.**
10. **Set three separate targets:**
    Cost reduction,
    Cost avoidance,
    Productivity cost reductions.
11. **Keep cost reduction administration expenses low.**
12. **Administer your program to stimulate an atmosphere of cost conservation.**
13. **Make cost reduction performance a factor in merit reviews.**
14. **Set memorandum targets for management engineering activities.**
15. **Don't accept unjustified cost reductions.**
16. **Have your auditors regularly check completed cost reductions.**

Formerly in the petroleum industry, Mr. Hamilton is now a consultant, 16 Buckingham Drive, Ramsey, New Jersey.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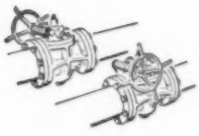

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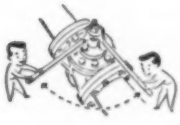

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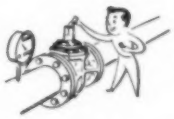

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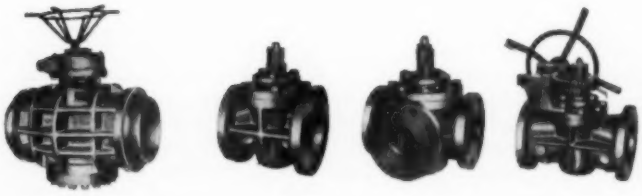

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but get no satisfaction in missing a cost reduction goal by 50 percent.

Another factor is that cost reduction targets are constant throughout the year. In the example mentioned the target is always $10,000 and progress in meeting the target is easily followed. Also, when performance against each departmental target is expressed in percentages and compared with other departments, inter-department competition is encouraged.

Third, targeting need not include all expenses while budget controls do. As a result favorable or unfavorable variances due to non-controllable items are excluded from progress in meeting cost reduction targets.

A fourth important factor is that cost reduction is reported on a non-calendar basis. Since any manager has a good working chance of meeting his cost reduction target right up through the last month of each calendar year, the incentive for improvement continues strong throughout the year. On the other hand, with budget controls, any operating saving that counts substantially against budget must be made early in the calendar or fiscal year. It is generally agreed that this tends to discourage improvements in the latter part of the calendar year.

Don't be handicapped by red tape.

Keep Rules Brief

It pays to keep cost reduction ground rules informal and simple. Your work should not be handicapped by red tape. It is good practice to prepare a short manual that defines and gives examples of cost reductions.

Design a brief form with space for listing previous actual (or previously planned) costs and a comparable statement on the new operation or plan, for use in reporting cost reduction.

It is best not to ask for pages of documentation with each project. You should make sure, though, that back-up information is available in the transmitting department.

Don't reduce the impact and effectiveness of your program by asking participating departments to offset savings made in one activity with unrelated increases occurring in another. Remember the main objective of your program is to create an atmosphere of cost consciousness and conservation.

Each department and individual should get full credit for all cost conservation. Reducing savings by deducting increases in unrelated items has a deadening effect on cost reduction drives.

For this reason don't try to use cost reduction savings to reconcile the variances between one year's profits and the next. Your cost reduction accomplishments should be considered a rate of participation rather than the accomplishment in any one year. You should be looking mainly for a high rate of new suggestions in place of exact bookkeeping on the amount accomplished in one calendar or fiscal year.

Effective Follow Up

Another key factor in a good program is to organize for a follow-up. The first step is naming a cost reduction chairman for the company. He can be head of your budget or cost control department, but preferably should be a separate administrator selected for this purpose. The chairman should have much of his time free for this work.

Next, see that each department appoints a cost reduction representative. The representative can be a member of existing line organization. In the operating departments the appointees should preferably be operating people, not members of a financial service organization. The chairman should make sure that each representative has needed time free for administering cost reduction activities in his department.

All representatives should meet regularly—at least bi-weekly—to discuss common problems and to plan action. Each meeting should review progress made by each participating department and each department's plans for future goals.

It should be clearly established in these meetings that each representative is responsible for a strong follow-up within his department to see that cost reduction ideas are forthcoming and are put into effect.

When plans made by any department show signs of a serious lag, hold "brainstorming" sessions with the department's key personnel. At these sessions the main purpose is to encourage participants to talk freely and to advance ideas, regardless of merit. Sometimes a seemingly implausible idea will lead to a worthwhile conclusion. So that all participants will express ideas freely it is best to restrict meetings to one supervisory level at a time.

Try to get your chief executive to address the regular cost reduction meetings in each major plant or office once each year. Supplement this with talks by your financial vice president, controller and by other top executives. Also, from time to time, schedule talks by those department and division managers who are doing an outstanding cost reduction job.

Set targets for cost reduction.

Set Stiff Targets

As a rule of thumb, your first year targets should average 5 to 10 percent of operating expenses. The same targets should apply to all purchased supplies. Special targets should be set for crude oil and other purchased raw materials.

If your program is administered and operated effectively, chances are you can continue the same target rates for several years. One reason for expecting continued high performance is that many projects take one or more years to plan and put into effect.

A single cost reduction target for each department is not enough to give you full benefits. High achievements can be obtained by setting three separate targets.

1. BASIC COST reduction target for improvements in methods, organization, yield and from lower prices paid for purchased products and services.

2. IMPROVEMENTS IN WORK pace . . . productivity cost reduction. Excludes any improvements from productivity gains from new facilities . . . includes all gains either from greater productivity from the same work force or from reduction in headcount caused by improvements in work pace.

3. COST AVOIDANCE target . . . credit for making improvements in plans. If all plans were perfect, no cost reduction could be accomplished. Since they cannot be perfect the cost avoidance program encourages careful scru-

tiny and improvements in plans. Cost avoidances are always reductions in planned costs. This is a hard and fast dividing line.

Cost Conservation

Your main objective is to encourage a feeling for cost reduction and cost conservation throughout the organization. Be liberal but realistic, in granting credits. Always be careful that you do not discourage cost reduction work by disallowing cost savings due to technicalities in your rules. Any legitimate savings or avoidance of expense should be accepted.

Generally, no cost reduction should be credited until the improved method, reduced price, increased yield or other conservation has been accepted and installed. You will weaken your program if you allow reduction credit for savings you only planned. If company policy, however, dictates that excess employees must be retained on the payroll, pending assignment to other jobs, the cost reduction should be allowed. Your objective should be to encourage making new methods operative as soon as practicable. Prompt action would be discouraged if no credit was granted until excess employees were absorbed.

Include all employees. Organize your program in such a manner that maximum influence is exerted on every employee to maintain a cost-conscious attitude. Each employee must be encouraged so that he is willing and anxious to advance any idea that may result in a savings no matter how small. If you have a suggestion system organize this system as part of your cost reduction program.

Psychology is an important part of a good cost reduction effort. Convince your supervisors and managers through examples of savings actually made that continuing accomplishments are practicable.

It will help if you have slides and a documentary tape showing the purposes of the program and illustrating typical good results. Show this to all administrative and supervisory employees and to other employees who can give major assistance in reducing costs.

Keep the cost of operating the system as low as possible. It not only saves expense but it is good psychology to operate with a minimum of organization and paperwork costs. One full time employee or less is usually enough for any program. You should scrupulously avoid expensive forms and records. All meetings of representatives should be brief and to the point.

Make cost reduction thinking an important part of the work-day life of each manager and supervisor. Accomplishments should be made a major factor in merit reviews. All managers and supervisors should be aware that their advancement with the company will at least partly depend on the cost reduction achievements of their organization.

Targets for Groups

Memorandum targets should be set for systems and procedures and other staff groups that have the analysis and reduction of expense as one of their main functions. It will help encourage cooperation between departments if actual savings are reported by the benefiting departments. This method of reporting encourages operating department acceptance of the management engineering activity.

In general, no credit is given to any department merely for advancing an idea. If a department other than a management engineering department actually steps in and helps develop the idea then the actual saving should be shared by the departments who work together in putting the idea into practice.

Special Rules

It will discredit your cost reduction program if unjustified reductions or avoidances are accepted. In the long run any oversight in equitably enforcing the rules is likely to come to the attention of other departments who are making a conscientious effort to abide by the rules. The chairman of the cost reduction committee must have authority to refuse credit. Also, he must be free to question any proposed cost reduction and require reasonable proof that it has been accomplished.

Beyond the surveillance of the cost reduction chairman or his representative, justification should be regularly examined by the auditing department. The audit should not insist on down-to-the-penny accounting but it should make sure that all departments are complying with the general rules discussed above. * * *

Soviet 1958 Plans for Oil and Gas

All phases of Russia's oil and gas industry will continue to set new records in 1958 under goals announced by the State Planning Committee.

Petroleum output will increase 14 percent to around 112 million metric tons* (840 million bbl), compared with an estimated 98 million metric tons in 1957 and 83.8 million metric tons in 1956.

Gas production will jump 52 percent to around 32 billion cubic meters,† compared with an estimated 21 billion cubic meters in 1957 and 13.7 billion cubic meters in 1956.

New Capital

Capital investment in the Russian oil and gas industry during 1958 will be four billion rubles ($1 billion) higher than in 1957—a 30.5 percent increase.

This will permit completion of an additional 1800 miles of natural gas pipelines and 1300 miles of oil and oil products pipelines, and the placing of additional refinery capacity in operation at the new Gorky, Stalingrad, Fergana and Perm (formerly Molotov) facilities. Construction will start during 1958 on other large refineries at Krasnoyarsk in Central Siberia, at Pavlodar in Kazakhstan, and at Polotsk in White Russia.

Exports Increase

Russian oil is flowing to world markets in record volume, according to the USSR's Ministry of Foreign Trade. Official figures for 1956 show that the Soviet exported 3.9 million metric tons of crude and 6.2 million metric tons of refined oil products. Largest importers of Russian oil and oil products in 1956 were Communist China (over one million metric tons), Finland (one million metric tons), Sweden, Egypt, Poland, Iceland, and Greece.

Over two-thirds of Russia's 1956 crude oil exports went to Communist bloc nations—East Germany, Czechoslovakia, Poland, Red China, and Hungary.

Value of Russian exports to Near Eastern and Southeast Asian nations soared from 66 million rubles ($16.5 million) in 1955 to 116 million rubles ($29 million) in 1956. The USSR provided 75 percent of Afghanistan's and 42 percent of Egypt's refined oil products imports in 1956.

Imports to USSR

Russia also imported 1.5 million metric tons of crude in 1956. Of this, 1.4 million metric tons came from Austria — 1.2 millions tons being received as annual payment for Soviet property turned over to Austria in accordance with a 1955 agreement.

The USSR imported 3.8 million metric tons of refined oil products in 1956, of which over 90 percent came from Rumania. * * *

*About 7.5 bbl to one ton.
†One cubic meter is 35.315 cu ft.

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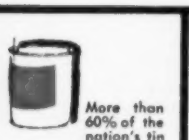

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Course Focuses on Controls

Executive development program organized around one theme — controls . . .These include reports, budgets, plans of wide application

A gathering in front of the main lodge.

W. T. Jerome III

THEME of the Syracuse University executive development program is that of business or management controls. These controls represent the impersonal data such as reports, budgets, or organizational plan — so much a part of management today.

Size of businesses, their geographical dispersion, their product diversity — in a word, their complexity — oblige managers to find some antidote. The Syracuse program thus grew out of the conviction that business controls, when systematically and wisely used, serve to simplify management's job.

Accordingly, the Syracuse Executive Controls Program is intended to enable its 26 participants to attain a better understanding of the uses of business controls. The faculty believes that focus on this single theme of business controls in a short four-week program is relatively more beneficial than a broad-brush treatment of common subject areas.

Objectives of the program are:

1. To show that such things as budgets or standard costs or auditing or return on investment are not matters exclusively reserved for accountants or treasurers, but can aid all levels of management in decision-making and in getting a job done;

2. To identify those areas in which operating people can call for assistance upon the figure experts, since most operating men have neither the time nor the inclination to become expert in everything;

3. To remove the aura of mystery from control, especially where such current developments as electronic data processing or operations research or certain statistical techniques seem to complicate matters for managers, and

4. To provide an opportunity for each man to develop both a knowledge and a philosophy of management control that will be useful to him when he gets back on the job.

Mr. Jerome is director, executive controls program, College of Business Administration, Syracuse University, Syracuse, New York.

The Executive Controls Program is designed for members of middle management — particularly those whose responsibilities increasingly call for general management skills as contrasted with those skills solely of the specialist.

Representation in the program comes equally from all the functional areas of business, such as production, marketing, finance, and engineering. This very diversity of interest and experience helps to emphasize the fact that many principles and techniques of control discussed at the conference center are company-wide in scope and universal in application.

The vast majority of the men fall within the age range of 35 to 45. There are no formal educational requirements.

The Syracuse program is offered once a year, usually in July or in August. It is four weeks long and costs $1000, including tuition, room, board, and books. Classroom meetings are held from 8 a.m. to 3 p.m. In the evening there is usually a guest speaker or voluntary special interest session. Each man also takes part in at least one panel presentation on a subject of his own choosing.

The conference site is at Blue Mountain Lake, one of the University's summer campuses in the Adirondack Mountains. The main lodge and adjacent buildings, including a large seaplane hangar now available for indoor recreation, were previously used for sales meetings by an eastern manufacturing company. Because of its relative remoteness from outside distractions, the site is ideal for a conference center.

Number of participants has thus far been limited to 26 per session. This size enables everyone to take part in classroom discussions. Considerable learning depends upon this "talking through" and "thinking through" common problems and experiences. The starting point for discussions may be a case study, an article of current significance, or a brief presentation of some material on control by one of the faculty.

A noteworthy feature of the program lies in its teaching faculty. This faculty is drawn exclusively from the University and, with only one exception, from the College of Business. As a result, the program is well integrated around the control theme. In addition, the college's own graduate and undergraduate curricula benefit from the "feed-back" of ideas that inevitably results from the give-and-take discussions between faculty and members of industry.

The teaching staff is all experienced. All but two of the nine hold doctorates. Most of the faculty hold consulting positions or have some business affiliations. Four of the faculty have either taught or received advanced degrees from the Harvard Business School. Faculty includes a retired major general, the head of the University's Business Research Center, and the former director of economic development of the New York State Department of Commerce.

In previous sessions as many as four or five of the participants have been from major oil companies. Characteristically, the petroleum industry has been keenly aware of the need for a well-defined approach to control, not just in the sense of preserving company assets but, even more importantly, in the sense of planning for profits in an ever-changing and expanding economy. The faculty of the Executive Controls Program accordingly looks forward to the continued participation by representative companies from the petroleum industry. ★ ★ ★

Almost total disclosure is the policy of many successful companies . . . Here's an item-by-item account of one firm's communications system. If your organization isn't all under one roof it's a good check list. Don't let your staff blunder because they aren't informed . . .

Secrets May Be a Stumbling Block

IN A DIVERSIFIED, decentralized organization communication becomes one of the most important management functions. Keeping the entire organization informed on policies and plans requires systemized methods. And methods used must not only inform outlying plant executives of new policies and decisions made in company headquarters, they must also promote greater self-reliance and company-wide cooperation.

Information for Decisions

To realize these goals, Rockwell Manufacturing Company, which has 22 plants in 15 states and Canada, follows a policy of almost total disclosure of operating information to various levels of management. Top management believes that plant executives need full information to make the right decisions in day-to-day operations. Plant managers and department heads receive all financial and operating data affecting the company, broken down in considerable detail. Perhaps more important, they are constantly updated on management thinking and planning in the light of changing business conditions. Employees at lower levels receive less information, but still, a considerable part of that available to higher management.

Nor is the information confined to the immediate responsibilities of the recipient. Rockwell makes 19 product lines for 28 major industrial markets, but most of the information from company headquarters goes out across division and product lines.

Benefits

There are three reasons for broadening vertical communications into company-wide reports. First, to operate with imagination and initiative, a plant management man must look beyond his own bailiwick. He must consider the effect of his decisions on the current status and long term plans of the company and their effect on operations in other parts of the company. He can pick up good ideas from their operations and avoid duplication of their efforts. Also, he knows where he can go for assistance on problems that have come up previously in other company plants or divisions.

Secondly, the Rockwell organization is composed of men with diverse backgrounds from the standpoint of markets, products, and "employer origin" (since the end of World War II, Rockwell has purchased 14 companies). Today, it is a highly cohesive unit and at least in part, because of communications policies. Personnel work well together, understand and appreciate the problems of the several divisions and have an unusually high degree of what can be called "company spirit."

Training Method

Finally, effective company-wide communications is good training for executives. Rockwell has built seven plants since 1951*, staffing them with executives from older plants. The dissemination of information on a company-wide basis prepares young men to take over more responsibilities in another part of the company or in company headquarters. An industrial engineer in a plant making valves becomes somewhat familiar with the problems of the power tool division. If promotion brings him into a new line of work, he doesn't have to go through a period of flying blind.

Person-to-Person

None of the formal methods used for communications are meant to replace the exchange of information that takes place day-to-day and person-to-person. In fact, the methods encourage an interchange at all levels. Since more people are informed about the general goals and plans of the company, they bring more to discussions of specific problems as they arise in day-to-day routines. But in a diversified, decentralized organization, communication becomes burdensome, time-consuming and haphazard unless methods for passing along recurring information are systemized.

Most of these methods are widely used. Each company must tailor them to meet its particular needs.

In addition to specific internal reports, opposite is a list to check for communications in your company.

Check list on opposite page supplied by Rockwell Manufacturing Company.

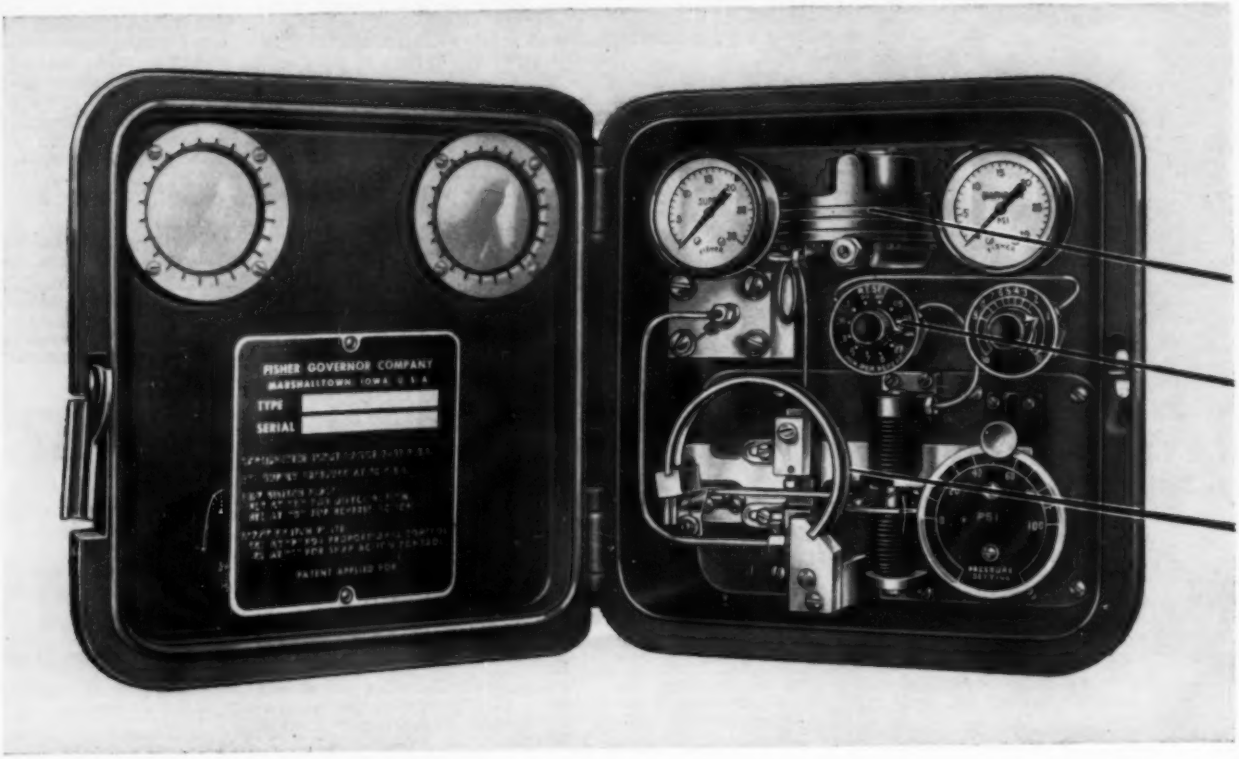
*This figure does not include one empty new plant bought by Rockwell and staffed the same way.

★ ★ ★

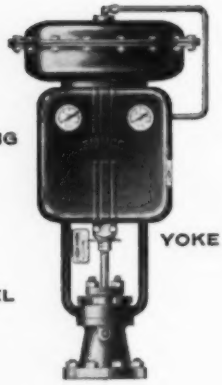
COMMUNICATIONS CHECKLIST

METHOD	PURPOSE	WHAT IS COMMUNICATED	TO WHOM
President's staff meetings; weekly.	To review current operations.	Discussion of progress of programs, and matters affecting current status of company, initiation of programs.	Top executives and operating men at headquarters.
President's "expanded" staff meeting; monthly.	To spread current management information to a broader group of key management personnel.	Much of the material covered in the President's weekly staff meetings — though in less detail and slanted to requirements of this broader group.	About 80 to 85 key headquarters personnel with broad administrative responsibility in sales, production, engineering, accounting, advertising, market research.
President's letter; monthly. Prepared by president and his staff.	To keep management informed of current operating status, long and short term planning and the president's thinking on matters affecting company.	Analysis of previous month's operations compared with preceding figures; analysis of inventories and inventory outlook. Matters of current interest; industrial and public relations, engineering, etc. Personnel changes.	Vice presidents, corporation department heads, plant managers, sales executives.
Division vice president's letter; monthly. Prepared by division v. p.	Same as president's letter.	Patterned after president's letter. Provides information pertinent to sales and operations in the division.	Divisional department heads and plant managers, sales managers.
Management newsletter; quarterly. Prepared by president and his staff.	To discuss current and anticipated operations with a wider group throughout the company.	Patterned on president's letter. Analysis of previous quarter's operations: sales forecasts and proposed changes to meet new forecasts. Plant budget information including complete analysis of actual costs compared to budget. Management tips submitted by personnel throughout the company. Subjects of current interest, e.g. training programs, new plant production, product development.	All management personnel from board chairman to foremen and sales engineers. (790 out of 7500 employees.)
Activity report; monthly. Prepared by plant manager and his department heads.	To inform headquarters of plant's programs, progress and problems.	Information on production plans and programs in the plant.	President, vice presidents, staff department heads.
Annual management meeting; annually in February. 3 days conducted by president; 3 days by division v. p.	To inform plant managers and sales organization of company-wide policies and plans for long term, and provide an opportunity to exchange information.	President's review of five years, past and future, including comparison of two-year balance sheets. Review of staff operations: Industrial engineering, purchasing, advertising, industrial relations, insurance credit, etc.	Plant managers, corporation staff men, regional sales managers.
Employee meetings; quarterly; conducted by president.	To keep all employees informed of company's status and plans and personnel policies.	Management's thinking on diverse subjects affecting employees, e.g. general business conditions, vacation policies.	All headquarters employees.
Research development report; quarterly.	To keep all divisions informed of all company product developments and plans; standardization program.	News of product developments and central and plant research laboratory projects and divisional engineering departments; news on standardization.	Management group including department heads.
"Hour of Enlightenment" meetings; bi-weekly.	To keep executives informed on operations outside their own fields; training in specialties of staff men.	General information on operations; e.g., controller discusses standard cost system.	Non-homogeneous group (50-100) of middle management line and staff men.
Supervisory conferences; held at department heads discretion.	Seek solutions to operating problems.	Discussion of specific operating problems as they arise.	Department supervisors.
Letters to supervisors.	To inform supervisors of specific operating problems as they arise; to pass along worthwhile ideas.	Announcements of new vacation policies, etc.; new procedures, e.g. for merit evaluations.	All supervisors at their homes.
Rockwell Report, by president; monthly.	To acquaint general public and business community with operations.	Informal monthly column including general information on Rockwell's philosophy of business and company activities.	Advertisement in business magazines and newspapers circulating to employees, customers, suppliers, stockholders and community.
Local "Rockwell Report" by local plant manager.	Same as Rockwell Report.	Information of interest to the specific community.	Advertisement in local newspapers.
House organ.	Encourage "community spirit" in the company; provide a media for explaining company policies, attitudes.	News of employees' activities; management's views on general problems affecting operations; features concerning safety, waste, suggestion program.	All employees.
Local house organ.	Same as company-wide house organ.	Same as company-wide house organ.	All employees of particular plant.
Internal publicity releases.	Inform key employees of company activities that make the news.	All news bureau releases to general and business publications, plus news releases of internal interest.	Management group including department heads.
Bulletin boards.	Inform employees of matters of general interest.	Information on plant social activities, company-sponsored neighborhood activities, safety information, internal publicity releases.	All employees.
Employee letters.	Encourage "community spirit" in company.	Holiday greetings, notice of community affairs, reminders to vote.	All employees (at their homes).

Basic Simplicity...faster



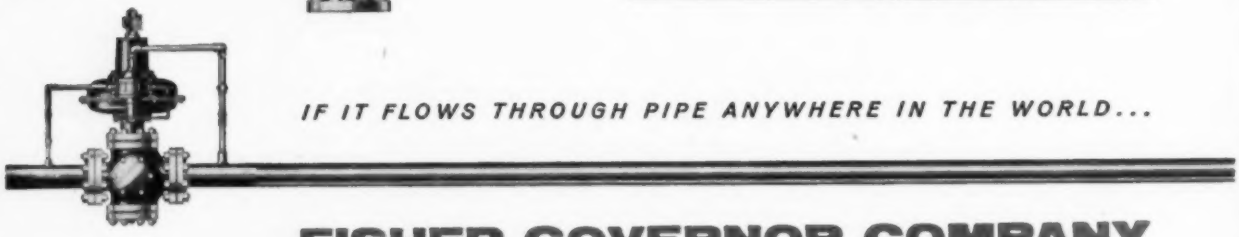
SURFACE MOUNTING



YOKE MOUNTING

FLUSH PANEL MOUNTING

PERFORMANCE DATA	
Test	**Results**
Air or Gas Consumption with 15 psi Output Pressure	Minimum at 10 or 0 Proportional Dial Setting—2 cfh Maximum at 5 Proportional Dial Setting—23 cfh
Resolution Sensitivity	Minimum Change Required in Measured Variable to Produce an Effective Movement of Final Control Element is 0.1% of Bourdon Tube Rating.
Repeatability	Ability of Wizard to Reproduce Its Output Signal for a Given Pressure Setting is 0.5% of Bourdon Tube Rating
Resonant Frequency	Unaffected at Usual Motor and Turbine Speeds.
Temperature Effects	Under Cold Box Test at —20° and Simulated Sun Test from 80° to 212°F Control Pressure Remained Within ±1% of Bourdon Tube Rating.



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FISHER GOVERNOR COMPANY

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response...greater stability

the WIZARD II PRESSURE CONTROLLER with New and Improved Features

1. **VOLUME RELAY** for faster response to pressure changes.
2. **RESET FEATURE** for greater stability and pin point control, assuring perfect metering, even on multi-stage meter runs.
3. **WIDE RANGE** brass, steel or stainless steel Bourdon tubes cover a range of from 25 to 10,000 psi. Bellows assemblies for low pressure regulation in ranges from 0 to 25 psi.

Again FISHER engineering produces features the industry needs to do a better job

The Wizard II has been designed to specifically meet the demands of modern, complex systems requiring closer control. The Wizard II retains all of the basic simplicity, accuracy and dependability of the Wizard 4100U, plus its own exclusive features.

The new design consists of two sub-assemblies encased in a weather proof die cast aluminum housing which is provided with a ¼" pipe threaded vent for gas service. Either assembly can be removed without disturbing line connections.

The upper assembly consists of two gauges, relay and proportional band adjustment. The lower assembly includes the set point adjustment, proportional bellows, Bourdon tube and nozzle. Each assembly is assembled and calibrated before mounting in the case. The case can be mounted on a flush panel, a wall or on the yoke of the control valve.

Careful and exhaustive tests have conclusively proved that the Wizard II measures up to rigid Fisher standards.

A completely descriptive and illustrated bulletin on the Wizard II is yours for the asking. Write for Bulletin No. D-4150.

The original Wizard I is still available for those applications not requiring volume relay and reset features.

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Management Personals

Russell H. Green was elected president of Signal Oil and Gas Company. It was also announced that **Samuel B. Mosher** had been elected to the newly-created position of chairman of the board of

R. H. Green

S. B. Mosher

directors and chief executive officer. It was also announced that **William E. Walkup,** who has been director in charge of finance since 1955, has been elected vice president. **Albion E. Stebbings,** formerly assistant secretary, was named secretary.

Mosher has been Signal's president since he founded the company as a small natural gasoline manufacturer on newly discovered Signal Hill back in 1922. Green joined the company three years later and became vice president in charge of operations.

C. J. G. Leesemann was appointed head of the supply and coordination division, Humble Oil & Refining Company's Houston offices. He has primary responsibility for coordination and liaison between the refining department and other company departments, and between Houston office and Baytown refinery and customers on matters relating to coordination of production and supply of products.

Dr. Robert E. Schilson and **Dr. Robert W. Parsons** have joined the staff of Ohio Oil Company's research center as research scientists. Each received his PhD in chemical engineering earlier this year and will work in the engineering section of the center.

R. E. Meinert, vice president of Lion Oil Company, a division of Monsanto Chemical Company, has relinquished his responsibilities as purchasing agent and manager of the general service department. He will continue as a vice president of Lion and assist the management in connection with the division. **L. Edward Tinnell,** assistant to Meinert since 1951, will assume the direction of purchasing and general service activities.

Douglas P. Bailey was named manager of the purchasing department of The Texas Company. He was previously manager of the operations division of the company's refining department. Bailey succeeds **Howard S. McCray,** who was elected chairman of the board of directors and chief executive officer of The Texas-Zinc Minerals Corporation in mid-February.

O. P. Puryear was named assistant manager (industrial), technical services division of Texaco's research and technical department. Puryear succeeds **R. R. Thurston,** who has retired. **Louis E. Endsley Jr.** was named to succeed Puryear as assistant manager (operations), technical services division. Endsley was formerly director of technical services.

Other changes at the Research Center, the company's largest research facility, were: **J. Stanley McKeown** succeeds Endsley as director of technical services. **Albert D. Togna** succeeds McKeown as supervisor of the field service department. **August Sellingsloh** succeeds Togna as supervisor of the products testing department. **Joseph L. Furtnett** succeeds Sellingsloh as assistant supervisor of the analytical department. **Neil H. Fick,** formerly group leader in the products testing department, succeeds Furtnett as chemist (staff) in technical services administration.

D. B. Vale, P. L. Kartzke and **G. Davidson** have been elected directors of Shell Oil Company of Canada, Ltd. Vale is executive vice president; Kartzke, vice president of exploration and production, and Davidson, vice president of manufacturing.

Harry J. Kennedy, who has been with Continental Oil Company for more than 38 years, and administrative vice president in charge of marketing since 1936, has been appointed a senior vice president. In his new position Kennedy, in addition to directing operations of the marketing department, will have reporting to him the industrial and public relations departments.

R. E. Clarke was elected president of Pacific Oil Company (California), a wholly-owned subsidiary of Standard Oil Company of California, with headquarters in San Francisco. Clarke succeeds **T. J. Galbraith,** retired. In addition to his new job, Clarke will continue as manager of natural gas utilization for Standard.

J. K. Roberts, director and vice president of Standard of Indiana, is U. S. chairman of a program committee for the Fifth World Petroleum Congress. He is also chairman of the Program Coordination Committee, responsible for final selection of papers on a worldwide basis. The U. S. National Committee members and the subjects for which they have invited papers are: **Dr. H. D. Hedberg,** vice president, Gulf, (geology and geophysics); **Harold Decker,** president, Highland Oil, (drilling and production); **C. K. Viland,** research and development, Tidewater, (oil processes and refining); **Dr. J. Q. Cope,** California Research Corporation, (chemicals from petroleum and natural gas); **Harry Levin,** research and development division, The Texas Company, (composition; analysis and testing); **A. J. Blackwood,** products research division, Esso Research and Engineering, (utilization of oil products); **S. D. Dalton,** manufacturing, Socony Mobil, (engineering, equipment and materials); **D. B. Hodges,** vice president, transportation and supplies, Shell, (transportation and distribution); and **J. W. Boatwright,** Standard Indiana, (operations research, statistics and education).

H. G. Vesper was elected president of Standard Oil Company of California, Western Operations, Inc. Vesper was formerly vice president in charge of marketing for Standard of California and is a former president of California Research Corp. He succeeds **E. J. McClanahan,** who has been named director of marketing for SoCal. McClanahan will continue as chairman of the board for Western Operations, Inc. He is a vice president and director of the parent company.

Wayne E. Glenn, Continental Oil Company, was elected president of the Denver Petroleum Club. Other officers are **R. W. Sullivan,** Denver attorney, first vice president; **R. L. Sielaff,** Tennessee Gas Transmission Company, second vice president, and **Otis Cargile,** Shell Oil Company, secretary. New directors of the club include **Collis P. Chandler,** Chandler-Simpson Oil Company; **William D. Hewit,** Hewit-Gulick Drilling Company; **C. W. Horstmeier,** Sinclair Oil & Gas Company; **R. L. Manning,** R. L. Manning Company, and **William W. Walmsley,** Sun Oil Company.

Sherry Heads "Old Timers" Committee for IPE

William J. Sherry, independent oil producer of Tulsa, was named chairman of the "Old Timers" committee for the International Petroleum Exposition to be held in Tulsa, May 14-23, 1959, according to W. K. Warren, president of IPE.

Sherry was chairman of the committee in 1953 and supervised the special activities planned for the more than 740 "Old Timers" registered.

Main feature of the "Old Timers" events will be the selection of six pioneers in the industry for special recognition. Gold medals will be awarded to the "Pioneer of Pioneers," chosen at large from the industry, and to pioneers in each of the fields of production, refining, pipeline and transportation, natural gas, and supplies and equipment.

Primary basis for the awards are age and contributions to the oil industry. Anyone may nominate "Old Timers" for consideration by writing Sherry, chairman of The Old Timers Committee, International Petroleum Exposition, Tulsa. A sub-committee, kept secret in order that no pressure can be put on them, will make the awards.

"Old Timers" honored at the last IPE held in 1953 were: (ages given were at time of award)

Pioneer of Pioneers — the late Harry J. Crawford, 86, chairman of the board, Quaker State Oil Refining Company.

Production — W. L. Connelly, 80, Tulsa, retired chairman of the board, Sinclair Oil and Gas Company.

Refining—the late Edwin B. Reeser, 80, retired president of Barnsdall Oil Company (now merged with Sunray).

Pipeline and Transportation—Wallace R. Finney, 60, retired executive of Jersey Standard.

Natural Gasoline — Dr. George G. Oberfell, 69, research consultant and retired head of the Phillips Petroleum research.

Natural Gas — Dr. Godfrey L. Cabot, 92, president of Cabot Carbon Company.

Supplies and Equipment — Wallace D. Wilson, 60, president, Wilson Supply Company.

Headquarters for the oil pioneers will be in a replica of the Drake well drilled in 1859, the first well drilled for oil in the United States.

Personals

P. C. Spencer, president of Sinclair Oil Corporation since 1949, has been elected chairman of the board and chairman of the executive committee. He will continue as Sinclair's chief executive officer. **M. L. Gosney** is retiring as chairman of the board and chairman of the executive committee. **E. L. Steiniger,** formerly executive vice president, operations, has been elected president to succeed Spencer.

P. C. Spencer

R. C. Frederick

R. C. Frederick, a veteran of over 30 years of service was appointed coordinator for gas and gas liquids by Gulf Oil Corporation. He was formerly vice president in charge of gas purchases and gas sales for the Pacific Northwest Pipe Line Corporation, with headquarters in Houston, Texas, and with Gulf in the planning and economics department.

Kermit Roosevelt was named director of governmental relations. Roosevelt plans to open offices in Washington D.C. In this newly created position, he will maintain liaison between the company and governmental agencies of the United States and other countries in which Gulf does business.

Dr. Gordon H. Stillson of the Gulf Research & Development Company, with laboratories in Harmar Township, has been named business manager of the research center. He succeeds **Horace W. Daugherty,** who has retired. Dr. Stillson has been assistant director of the business management division at Harmarville, which is responsible for the general services of the laboratory, for the past ten years.

M. R. Hayes was named manager of Phillips Petroleum Company's foreign department Canadian operations with headquarters in Calgary, Alberta. Hayes, who joined Phillips in 1942, had been superintendent of the production department's western division, which includes West Texas and New Mexico, since 1951.

George J. Hanks, chairman of the executive committee and former president and board chairman of South Penn Oil Company has retired. Hanks was vice president and a director of Tidewater Oil Company before joining South Penn in 1944 as executive vice president. He became president later that year and moved up to chairman and chief executive officer in 1952. Hanks held this position until the 1955 merger of South Penn and the Pennzoil Company. He became president again at that time. **John E. Selden** succeeded Hanks as president last June. Hanks will continue as a director and consultant with the company. **Robert W. Grunert,** senior vice president of South Penn Oil Company, has been transferred to company general offices in Oil City, Pennsylvania, from Bradford, Pennsylvania. He will continue as vice president in charge of production and will also direct the Joseph Seep Purchasing Agency.

Jerome C. Eppler has been elected to the board of directors of the Vickers Petroleum Company, Inc. He is a partner in Cyrus J. Lawrence and Sons, New York investment firm.

N. A. Rousselot, vice president and general manager of Seaboard Oil Company's western division, Los Angeles, has retired.

Lindsey Hatchett, vice president Arkansas Louisiana Gas Company, was named supervisor of all Arkansas operations.

DEATHS

Arthur F. Bridge, former president of Southern Counties Gas Company from 1947 to 1954, died March 25 near San Francisco following a lingering illness.

Roy R. Riordan, 50, salesman for Plastic Engineering and Sales Corporation, died of a heart attack March 21.

Peter J. Varini, 36, a senior geologist for Sun Oil Company at Dallas, died suddenly April 5 following a heart attack suffered at his home in Richardson, Texas.

Robert Paul Ingram, 71, retired general superintendent of export terminals for the Warren Petroleum Corporation, died of a heart attack March 7.

Robert L. Hutchison, 54, vice president in charge of operations and a member of the board of directors of Columbia-Southern Chemical Corporation was killed March 21 in an automobile collision en route to his offices.

Whether you need a repair job in a hurry or a quantity of engines for a new project, we are equipped to handle your needs quickly and efficiently.

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3. Threads 4 sizes of pipe with 1 set of dies—quick size change. Dies for stainless steel available.

See 65R-TC before you buy—at your Supply House

The Ridge Tool Company, Elyria, Ohio, U.S.A.

Laugh with Barney

An oil company felt forced to cutback its maintenance crew when the slump hit the oil business. By mistake the billing department failed to bill one of these employees for a case of motor oil he had bought several months earlier. When they finally did get around to sending a statement to this man he had already been laid off. The man replied:

March 2nd, 1958

Dear Oil Company,

Enclosed please find statement sent to me and my ck for $6.84. I bought this oil Nov. 6, not Nov. 29.

Since you wait 3½ mos. before billing me. And bill me One mo after Your company layed me off I am post dating my ck for the above amount. To July 6, 1958.

Pound Salt

Barney says things are tough all over!

* * *

Fortune Teller: "You'll be poor and unhappy until you are 40."

Unemployed: (hopefully) "Then what?"

Fortune Teller: "You'll get used to it."

* * *

There's a new deodorant called Vanish. After you rub it on, you disappear and nobody knows where the smell comes from.

* * *

There's a vast difference in making a peach cordial and making a peach turnover.

* * *

An aged mourner slowly limped to the bier and for a long time stood there staring at the face of his departed friend. The funeral director approached him. "How old are you, sir?" he asked.

"I'm 98," came the whispered reply.

Holding him by the arm the funeral director asked: "Hardly worth going home, is it?"

* * *

"Is your daddy in, Sonny?"

"No, sir. He hasn't been home since Mother caught Santa Claus kissing the maid."

* * *

The curse of drink is being stuck with the check.

* * *

Figures don't lie but girdles condense the truth.

* * *

You have reached middle age when you've learned how to take care of yourself and intend to begin almost any day now.

* * *

He has Tarzan eyes. They swing from limb to limb.

* * *

"Where have you been keeping yourself?" one blonde asked another.

"I haven't," the other replied.

* * *

The young husband completed his application for membership in the High Fidelity Music Appreciation Club and then was asked about membership for his wife.

"Oh, I doubt if she could belong," he said.

"That's strange," said the secretary. "Most anyone can belong."

"My wife is peculiar," the husband explained. "She's low on fidelity and high on frequency."

* * *

If you are a poor speller, it helps if your handwriting is terrible, too.

* * *

Two old ladies were enjoying the music in the park. "I think it's a Minuet from Mignon," one said.

"I thought it was a waltz from Faust," said the other.

The first went over to what she thought was the board announcing the numbers. "We're both wrong," she said. "It's a Refrain from Spitting."

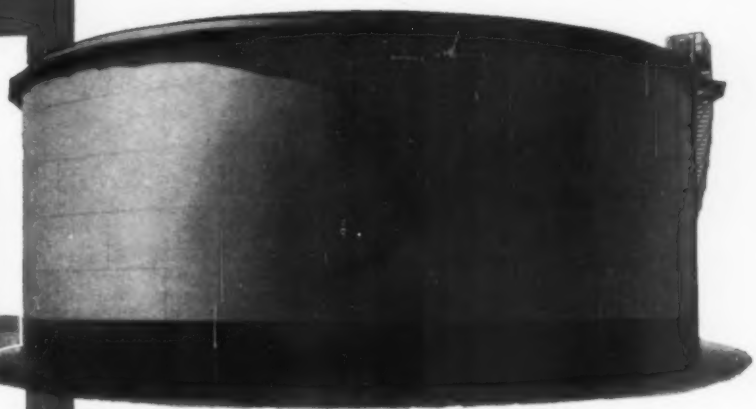
* * *

Unimportance is the sensation that comes when you make a mistake and nobody notices it.

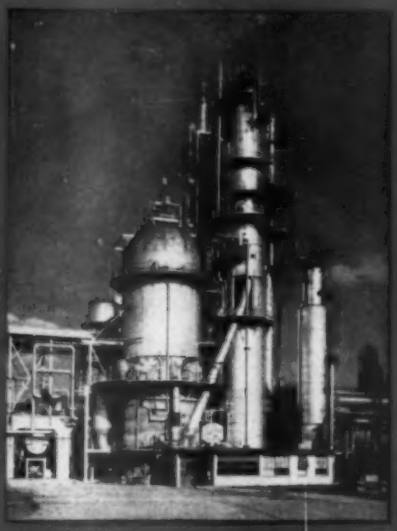
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

HAMMOND

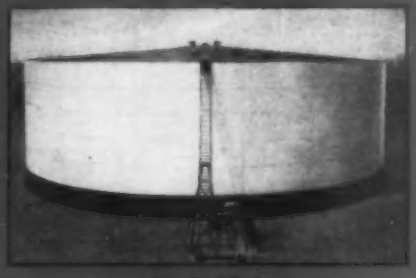
STORAGE TANKS and PLATE FABRICATION



Hammond **TUBESEAL*** and **SPRINGTITE*** Floating Roof Tanks



Process Vessels—Steel • Stainless • Alloys • Cladmetals



Cone Roof Tanks

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HAMONDTANK

• News
• People

The Trade PARADE

SHAND AND JURS Company, a subsidiary of General Precision Equipment Corporation, will spend over $500,000 on an accelerated research and development program to develop remote supervisory control systems for the petroleum and chemical process industries. According to R. M. Young, president, the program will continue over a two-year period. It will be administered by the company's Electrical Products Division, Berkeley, California. Photo shows a view of laboratory where work will be carried out.

CONSTRUCTION OF a permanent plant for the General Electric Computer Department has begun in Deer Valley Park, near Phoenix, Arizona. General Manager H. R. Oldfield, Jr., said the building will bring the permanent investment of the Computer Department in the Phoenix area to $4-5 million.

A FAMILIARIZATION COURSE, complete with a classroom in the form of a test well, and a unique system wherein participants serve as both students and teachers, has been launched at its Houston headquarters by Brown Oil Tools, Inc. Purpose of the course is to train salesmen, operators, supervisors and distributors in the operation of new tools and equipment. It is felt by Brown management that to keep abreast of the quickly changing equipment and methods in the oil industry requires constant training.

THE YOUNGSTOWN SHEET and Tube Company broke ground for a new sintering plant in another expansion step at its Indiana Harbor Works in East Chicago. When completed, sometime during the spring of 1959, the sintering unit will be the most modern in the steel industry. Contractor for the new plant is the Arthur G. McKee & Company, of Cleveland.

THE ROBERT MUDDIMAN Company has been named distributor of W-K-M ASA through-conduit gate valves, Key Kast and Key refinery fittings. The Muddiman Company, with offices in Toronto and Montreal, serves the entire eastern part of Canada. W-K-M with its office and plant in Missouri City, Texas, is a division of ACF Industries, Incorporated.

WELEX, INC., opened a new operating base for oil well service on the new expressway at Harvey, Louisiana. The new building and facilities are especially designed and equipped to offer maximum service and communciations to the oil industry in South Louisiana. The wireline skid units on offshore drilling platforms and mobile rigs will be handled by Dean W. Kelley. Others include field operating engineers, Charles W. Tipps, Doyle J. Prince, J. L. Everett and Ned A. Miller, all thoroughly trained and experienced in electrical well logging, jet perforating and other wireline services.

Karl Carlson will be manager of barge units designed and equipped for inshore work.

Division engineering offices and laboratories for all of South Louisiana are included in the installation headed by W. R. Jay and Lewis A. Cobb. Division drafting and printing under Don Robertson will complete the installation.

In order to assure the best communications with all field operations, Welex is installing its own radio station with a 340-foot antenna tower and a special beam antenna directed to offshore operations.

WILSON SUPPLY Company, one of the nation's leading oil field supply houses, was added to Lone Star Steel Company's list of distributors. Walter T. Moreland, Lone Star's vice president, sales, and Wallace D. Wilson, president of Wilson Supply, jointly announced the new affiliation effective immediately.

FURTHER EXPANSION by Tex-Tube, Inc. through opening a division sales office in Tulsa, Oklahoma, has been announced by Charles A. Carter, president. It is headed by R. B. Wallace as manager.

This ball foretells less pump downtime

Actual production records prove—Kennametal* API Balls and Seats stay on the job 3 to 5 times longer than "Super Alloys," and up to 20 times longer than steel. See Kennametal's new high-polish, "crystal finish" seat.

Kennametal Balls and Seats are stocked as replacement parts by most pump manufacturers—available for immediate delivery. Be sure to specify KENNAMETAL. For descriptive leaflet write to KENNAMETAL INC., Latrobe, Pa.

*Trademark

INDUSTRY AND
KENNAMETAL
...Partners in Progress

MUELLER

line stopper fittings and equipment

- **ISOLATE SECTIONS OF LINE**
- **TIE-IN LINES AND LOOPS**
- **REPAIR LEAKS AND EQUIPMENT**
- **REPLACE AND INSTALL EQUIPMENT**

...without interrupting flow!

use this simple procedure:

Fasten stopper fittings to line.
Attach gate valves to fittings.
Cut out sections of pipe in fittings with drilling machine.
Attach stopping machines to gate valves.
Connect by-pass line.
Establish flow in by-pass line.
Lower stoppers and stop-off line.
Blow-down isolated line section.
Make repairs, tie-ins or installations.
Purge line and build up pressure in line.
Relax and raise stoppers.
Remove by-pass line.
Plug fittings.
Remove gate valves.
Cap fittings.

Turn the page for catalog information on line stopper fittings and equipment for 1½", 2", 3" and 4" lines.

MUELLER NO-BLO®

MUELLER CO.
DECATUR, ILL.

Form No. PI-8876

Printed in U.S.A.

stop-off lines from 1½" through 4"

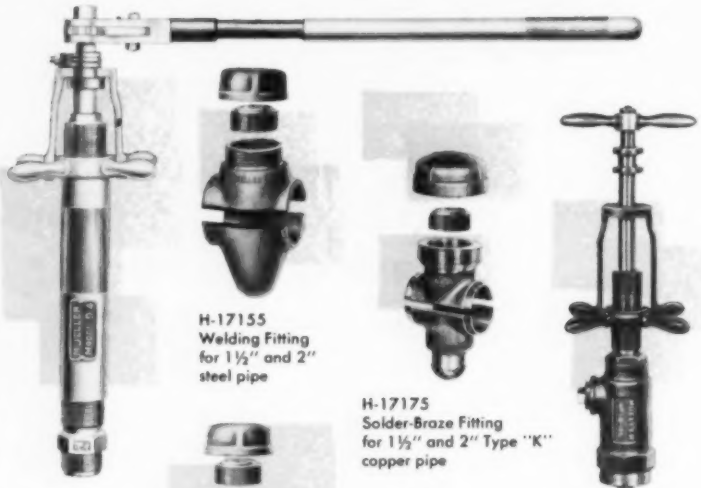
Mueller line stopper unit No. 1
. . . for stop-offs on 1½" and 2" lines.

Line Stopper Unit No. 1 is used to stop-off 1½" and 2" steel, cast iron or copper lines under pressures up to 125 p.s.i. and temperatures to 250° F.

The "D-4" or "DH-2" Drilling Machine is used to cut out the section of pipe in the fitting. The "D-4" is hand-operated; the "DH-2" is hand or power operated.

The H-17135 Stopping Machine is used to insert, expand and extract 1½" and 2" solid or by-pass rubber stoppers; insert and extract 2" deferred completion stoppers; and to insert and extract 1½" and 2" completion plugs.

Unit No. 1 consists of machines and attachments for stopping-off two fittings at one time to isolate a section of pipe.



D-4
Drilling Machine

H-17155
Welding Fitting
for 1½" and 2"
steel pipe

H-17175
Solder-Braze Fitting
for 1½" and 2" Type "K"
copper pipe

H-17165
Mechanical Joint Fitting
for 2" steel pipe
for 1½", 2" and 2¼"
cast iron pipe

H-17135
Stopping Machine

Mueller line stopper unit No. 2
. . . for stop-offs on 3" and 4" lines.

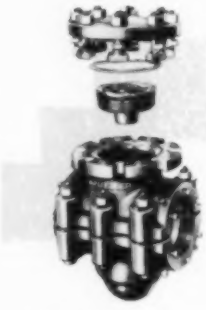
Stop-offs may be made on 3" and 4" steel or cast iron lines under pressures up to 100 p.s.i. and temperatures to 250° F. with the Mueller Line Stopper Unit No. 2.

The section of pipe in the fitting is cut out with the new, automatic Mueller CH-6 Drilling Machine. The CH-6 may be hand-operated with a ratchet handle or power-operated with the Mueller H-601 Air Motor or the Mueller H-602 Gasoline Engine Drive Unit. No changes in the machine are needed to use either hand or power operation.

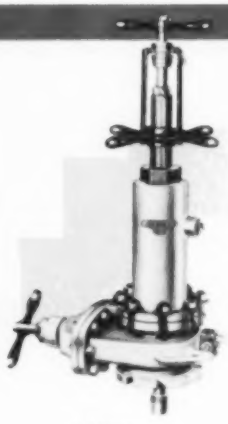
The H-17235 Stopping Machine is used to insert, expand and extract 3" and 4" solid or by-pass rubber stoppers; and to insert and expand 3" and 4" deferred completion stoppers and completion plugs. The steel body has a 1¼" inside I. P. thread by-pass connection.

Two stopping machines are included with the Unit No. 2.

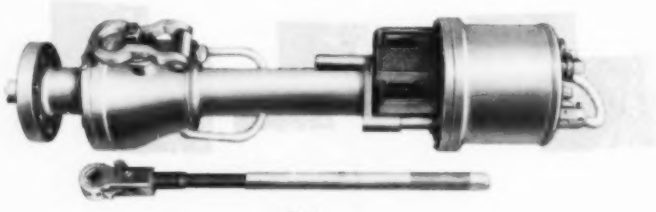
H-17255
Welding Fitting
for 3" and 4" steel pipe



H-17265
Mechanical Joint Fitting
for 3" and 4" steel
or cast iron pipe



H-17235
Stopping Machine



CH-6
Drilling Machine

Contact your Mueller Representative or write direct for full specifications on Mueller Line Stopper Units for stop-offs up to 12".

NO-BLO

Since 1857 Serving

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles.
In Canada: Mueller, Limited, Sarnia, Ontario

CHEMICAL PROCESS Division is adopting the name and trademark identity of BJ Service, Inc. Decision to unify all operations of the two oil well service companies was reached by key executives of both firms to gain "greater" service strength and additional "operating efficiency." Chemical Process has been operating as a separate division of BJ Service since their merger a little more than a year ago.

A NEW SALES development section has been established by Du Pont's Explosives Department to provide technical service to customers and develop sales for its chemical and specialty products. It will be headed by Dr. Marshall F. Acken, formerly manager of the chemical sales section. Henry R. Herring, manager of technical service and development in the chemical sales section, has been appointed assistant manager of the new organization.

JONES & LAUGHLIN is now exclusive distributor of replacement parts for Gardner-Denver mud pumps in the state of Kansas. Jones & Laughlin was recently appointed co-distributor of Gardner-Denver mud pumps and will eventually become exclusive parts distributor for the United States and Canada, with the exception of California which is outside J&L's area of operations.

POLYKEN SALES Division of The Kendall Company recently enfranchised Cathodic Protection Service, 4601 Stanford, Houston, Texas, to provide increased service for the Southwest area. Cathodic Protection Service maintains branch offices in Tulsa, Oklahoma; New Orleans, Louisiana; Corpus Christi, Texas, and Odessa, Texas. The distributor carries the complete Polyken Polyethylene Protective Tape Coatings line.

MERGER PROPOSAL between Armco and National Supply will be submitted to stockholders in April. The plan provides for transfer of National Supply's assets to a new subsidiary prior to the merger, after which the business of National Supply will be conducted in that name with substantially the same personnel. Under the merger agreement stockholders of National Supply will receive 85/100ths share of Armco stock for each share of National Supply.

A. T. GREEN Machinery Company, Route 8, Pittsburgh, has been appointed as distributors for the complete line of Cleveland trenchers, sidecranes, backfillers and tampers. The Green organization will handle sales, parts and service of Cleveland equipment in western Pennsylvania.

LE ROI DIVISION, an operating unit of Westinghouse Air Brake Company, has sold the assets of its engine business to Waukesha Motor Company. The line of internal combustion engines made by the Le Roi Division, along with certain inventories, special tools and equipment, make up major assets involved in the transaction.

HYCALOG, INC., has acquired a wholly owned Canadian subsidiary. Located in Calgary, Alberta, it will operate under the name of Prairie Coring and Supply Ltd. William B. Crane is the manager. The company will serve as distributor for sales of Hycalog diamond coring bits, diamond drill bits, washover shoes, and diamond core barrels. It will also operate as a service company for diamond coring.

HOUSTON OIL FIELD Material Company has opened a fishing and cutting tool location in Pampa, Texas. The store will be under the supervision of J. O. (Bill) Redmon and Hoyt Johnson of Oklahoma City. The store has a complete line of fishing and cutting tools and electrical well services.

A SLOGAN CONTEST — as a "kick-off" prelude to its centennial year — has been launched by Gardner-Denver Company among its employees and their families.

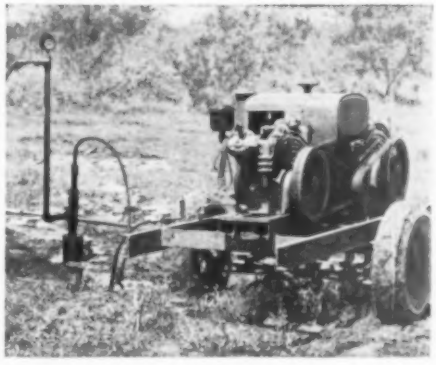
Ten shares of Gardner-Denver stock will be awarded the first prize winner, and additional prizes of $50 will be given to each of 10 semi-finalists.

Honoring Gardner-Denver's centennial year in 1959, the contest is open to all of the company's more than 4600 employees and their wives and children, except officers, directors and contest officials. Overseas employees are also eligible.

A SEPARATE DEPARTMENT was formed to handle sales of its rapidly expanding utility wheel and crawler tractor line, announced J. I. Case Company, Racine, Wisconsin. Brought out to supplement the company's larger wheel and crawler units, the new line of smaller machines will be sold and serviced by a broad network of dealers, in order to provide the intensive market coverage required.

Heading up the new Utility sales operation is William J. Schlapman, a veteran of 17 years in the construction equipment industry. Assistant sales manager, Utility line, is W. H. Vogel, who has a background of 18 years in this field.

This Wisconsin-Powered Trailer Unit produces Oil by AIR LIFT!



Of special value for pumping low production wells, where operating cost economics are of vital importance, Wisconsin Heavy-Duty Air-Cooled Engines are again proving their unique versatility, and load-lugging dependability.

As every oil field operator knows, newly drilled wells will sometimes have a low gas-oil ratio and subnormal rock pressure which will prevent oil from flowing. By injecting gas or air at the bottom of the hole at medium low pressure (depending on the depth and size of tubing), the oil will be lifted out of the bottom of the hole. At the same time this applied pressure loosens the sand and shale, thus creating a larger reservoir for accumulating oil.

Pictured above is a two-stage compressor unit with a capacity of 50 CFM, driven by a Model VH4D V-type 4-cylinder Wisconsin Air-Cooled Engine with clutch. This installation is operating at the La Vernia oil field near Seguin, Texas, on shallow wells (800 to 1200 ft.) with a low production of 2 to 4 bbls. per day. Well tubing is ¾", casing 2" and flow lines 1¼" . . . tailor-made for the job.

The Wisconsin Power Unit provides the all-weather serviceability, rugged work-ability and low cost operation and maintenance that a job of this kind calls for. You can't go wrong by specifying "Wisconsin Power" for your equipment.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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619 SOUTH MAIN STREET • TULSA, OKLAHOMA
3420 McKINNEY AVENUE • HOUSTON, TEXAS
805 SOUTH MAIN STREET • WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

A8-6135

. . . that has never failed through 44 years of continuous operation

You must be sure of the financial strength and responsibility of the insurance company before you buy insurance.

The Texas Employers' Insurance Association has a perfect record of performance covering 44 years of providing sound, dependable protection for the employers of labor in Texas. The last statement of the Association shows a surplus of $8,358,100 for the protection of policyholders . . . the greatest margin in its history.

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HARLINGEN • HOUSTON
LONGVIEW • LUBBOCK
MIDLAND • ODESSA • PORT
ARTHUR • SAN ANGELO • SAN
ANTONIO • SHERMAN • TYLER
WACO • WICHITA FALLS

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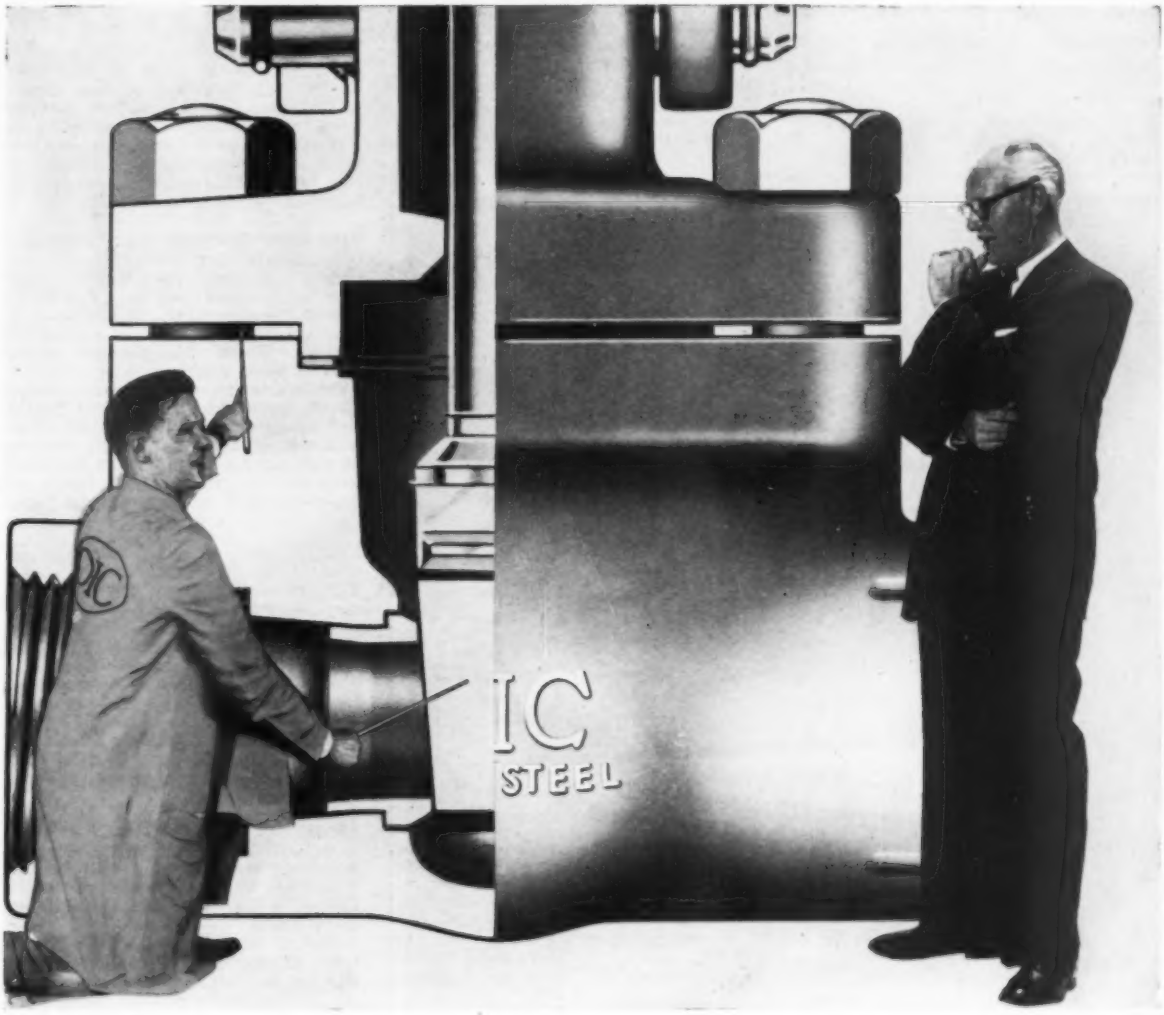
HOME OFFICE:
EMPLOYERS INSURANCE BUILDING
DALLAS, TEXAS

AUSTIN F. ALLEN, *Chairman of the Board* BEN H. MITCHELL, *President*

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

...and you can see here....and here, sir, how we've killed maintenance problems on our new forged steel lines.



We stop galling and erosion by giving you 13% chrome stainless steel trim with wedges *duracased* to a rugged *1000 Brinell hardness.*

The square and *bolted* body-bonnet joint makes it easy to service the valve quicker. And it's a tighter joint, made doubly leakproof by recessing the soft iron gasket into the body. The gasket can't blow!

And you get the fastest joint make-up you've ever seen. Look at those pipe ends. See the extra wrench-gripping area and lugs. See how body-bonnet flanges are out of the wrench's way. No time lost here!

These new 600-lb. OIC forged steel valves are available with either *high-flow* ports (1300 line), or *standard-flow* ports (1100 line). Call your OIC Distributor, or write for specification literature.

The Ohio Injector Company • Wadsworth, Ohio

OIC VALVES | BRONZE, IRON, FORGED AND CAST STEEL, LUBRICATED PLUG VALVES

Trade Parade

ALLIS-CHALMERS Manufacturing Co., Milwaukee, Wisconsin, will construct new engineering, development and research laboratories in Greendale, a Milwaukee suburb about two miles south of the Allis-Chalmers West Allis Works.

The new facilities will be housed in a one-story masonry, glass and steel panel building to be erected on a 30-acre site. A staff of 150 to 200 scientists, engineers, draftsmen, technicians and administrative personnel will be employed at the facility.

PURCHASE BY CUMMINS Engine Company, Inc., Columbus, Indiana, of Atlas Crankshaft, Inc., Fostoria, Ohio, was announced jointly by R. E. Huthsteiner, president of Cummins, and Edward A. Harper, president of Atlas.

The Fostoria concern machines crankshafts for nearly 20 leading manufacturers of diesel and gasoline engines, and various types of compressors. Cummins Engine Company has been a major customer of Atlas for several years.

AMERICAN POTASH & CHEMICAL Corporation opened a south-central district sales office at Shreveport, Louisiana, to handle the company's expanding interests in the states of Louisiana and Mississippi and parts of Alabama, Texas, Oklahoma and Arkansas. William W. Young, southern area sales representative with the company since 1949, is district sales manager of the branch, at 1600 Fairfield Avenue, Shreveport. Niven D. Morgan has joined the company as sales representative to operate out of the Shreveport office.

ARCCO
LIQUID GRAVITOMETERS
NOW 19 MODELS
MODEL RES
ARCCO—Anubis
For RECORDING, SIGNALLING TRANSMITTING and CONTROLLING
For pipelines, refineries, chemical plants, etc., ARCCO Anubis Liquid Gravitometers are ruggedly built for hard field usage yet are accurate in performance as a laboratory instrument.
Temperature corrected, these extremely accurate instruments are adaptable to high pressures and are available with internal parts suitable for practically all corrosive liquids.
Send for Bulletin No. 111R-3.
AVAILABLE FOR EARLY DELIVERY
AMERICAN RECORDING CHART CO.
3113 E. 11th St. • Los Angeles 23, Calif.
Send for Bulletin 111R-3

MAJOR CHANGES in organization of Beckman Instruments, Inc., are contemplated as a result of a survey conducted by management consultants retained by the company, Dr. Arnold O. Beckman, president, recently announced.

Beckman Instruments has operated with six virtually autonomous domestic divisions in eight plants in three states. With the contemplated changes, a greater measure of corporate control will be exercised to obtain the benefits available from closer coordination of the company's varied activities.

Seven key executives will be added to the corporate staff under the new plan, Dr. Beckman said, with primary responsibility for research, product development, manufacture, corporate sales, industrial relations and finance to be maintained at the corporate level. Heretofore, each division has carried on most of these functions largely independently.

THE CLEVELAND, Ohio, district sales office of The Babcock & Wilcox Company's boiler division was moved to 1367 The Illuminating Building, 55 Public Square, Cleveland 13.

DELTA TANK Manufacturing Company of Baton Rouge has appointed Mid-Continent Supply Company as exclusive distributor of Delta's oil field equipment. The agreement under which Mid-Continent assumes sales and service of Delta oil field equipment throughout the world (with the exception of Mexico) links two major members of the petroleum industry.

BETHLEHEM SUPPLY Company announces the opening of a store at 406 East Main in Woodward, Oklahoma. The store will maintain a stock of drilling and production equipment and general supplies applicable to the activity of the area. W. T. Davis, district manager from Oklahoma City, will supervise. R. E. Skelton, formerly at Ponca City, will be in charge of the new store.

D. G. Collins, machinery sales representative, has been promoted to store manager and field representative at Farmington, New Mexico.

EIGHTY-ONE EMPLOYEES of Beckman Instruments, Inc., whose ideas for improving manufacturing methods and procedures will save the company nearly $40,000 a year, were honored at a dinner March 6.

Earl C. Janson, director of manufacturing for the Beckman Fullerton plant, was keynote speaker, praising committees for developing new techniques to reduce costs, cut operator fatigue, eliminate safety hazards and speed delivery of Beckman products to customers. He urged continued application to daily tasks of the class-room principle.

MASON-NEILAN, division of Worthington, with headquarters in Norwood, Massachusetts, has established a new instrument sales division, with James M. McAlear as manager. He will supervise the sale of Masoneilan Instrument line: Pneumatic controllers, 60,000 Series, liquid level controls, temperature and pressure transmitters, etc.

ENGLER INSTRUMENT Company of Jersey City, New Jersey, manufacturers of registering and recording devices, announce the agreement for the exclusive national distribution of the famous V D O Tachograph, manufactured by the V D O Instrument Company of Frankfurt, Germany, and Detroit, Michigan.

ROLO MANUFACTURING Company, Houston, world-wide distributors and manufacturers of petroleum production metering and separating equipment, will manufacture and sell the Fish Calcium Chloride gas dehydrator under terms of an agreement reached this week with the Fish Engineering Corporation of Houston. R. K. Franklin, president of Rolo Manufacturing, said that the Fish dehydrator will be added to the line of equipment Rolo provides for the oil and gas industry. Rolo will manufacture the units in their Houston plant for both stock and custom installations.

THE EL DORADO, Kansas, store of The National Supply Company, in use since 1927, has been completely modernized. Improvements include a new store front of brick, glass, and metal, in keeping with those of the company's newest stores, and a remodeled sales room. Vernon L. Goodman is manager. National Supply has had a store in El Dorado since 1916.

JOHN B. O'CONNOR, president of Dresser Industries, Inc., of Dallas, Texas, was awarded the honorary degree of Doctor of Commercial Science by St. Bonaventure University May 1. O'Connor has many firsts to his credit, among them the development of the high-speed engine-driven angle compressor for oil field service. He built the first complete gas liquefaction plant in Russia.

A NEW ONE-STORY aluminum-clad building containing 61,000 sq ft of floor space was opened by Walworth Company, manufacturers of valves and pipe fittings, on Route 8, in Glenshaw, Pennsylvania, a suburb of Pittsburgh.

The new building, which will house the Central Division's sales and distribution for the greater Pittsburgh area, will also serve customers in West Virginia, most of Ohio, portions of western New York, western Pennsylvania and sections of Maryland, Indiana and Kentucky.

Executive offices of Walworth will also have new and larger quarters at 750 Third Avenue, New York 17, New York.

COMMON STOCK of Extruders Inc., Hawthorne, California, suppliers of polyethylene film to West Coast markets, has been acquired by The Dow Chemical Company, and becomes a Dow subsidiary. It will continue to operate as before under the same management: William B. Sander, president, and John A. Croft, secretary. Extruders was founded in 1948 and now employs approximately 80 persons.

SECURITY INTERNATIONAL, C. A., is the new world-wide sales representative (outside the United States and Canada) for all Security rock bits, hole openers, roller reamers, rubber stabilizers, and casing scrapers manufactured in Dallas, Texas; Whittier, California; and Manchester, England.

Security International has established principal offices in Caracas, Venezuela, for sales and service in the Western Hemisphere.

Western Hemisphere office is at Apartado 4880, Correos Del Este, Caracas, Venezuela, South America manager is S. C. Welker. Eastern Venezuela district manager is A. R. Patton. Western Venezuela district manager is B. A. Barker.

Eastern Hemisphere office is at English Steel Corporation, St. Ermins-Caxton Street, London SW-1, England. Sales manager is Harold Hall; assistant manager, Peter L. Winter.

MIDCONTINENT TUBE SERVICE, Inc., has formed a new affiliated company, Midco Valves & Fittings, Inc., to provide their pipe customers with necessary adjuncts to tubular steel products, it was announced by Sam Horwitz, president.

The valves and fittings division of Crane Company has named Midcontinent Tube Service, Inc., as distributors of its products. These products thus fit into the new Midco Valves organization. Both MidcoTube and Midco Valves are at 2120 Lee Street, Evanston, Illinois.

A NEW WIRE LINE service company has been set up by Oilfield Sales & Service, S. A., a subsidiary of U. S. Industries, Inc. The new company, Oilfield Wire Line Service, S. A., will function as a subsidiary of Oilfield Sales & Service, which is one of the leading distributors of oil field equipment in both Venezuela and Colombia. The wire line company will maintain an office in Maracaibo but operations will be conducted from a base camp maintained by Oilfield Sales & Service in Tia Juana.

Hold First Sales Meet

The newly formed Forged and Fittings Division held its first general sales meeting recently at the Cleveland Forge Works, Cleveland, Ohio. A brief history as well as aims and objectives was presented by Jackson Kemper, vice president and general manager.

Burton Schellenbach, vice president in charge of sales, H. K. Porter Company, Inc. outlined the corporate approach to sales.

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COUPLINGS

FOR OIL COUNTRY USE

LINE PIPE COUPLINGS A. P. I.
1/8" to 12" — Seamless and Special Processed — Black or Galvanized

PLAIN TUBING COUPLINGS A. P. I.
1" to 4" — Seamless

EXTERNAL UPSET TUBING COUPLINGS A. P. I.
3/4" to 3 1/2" — Seamless

CASING COUPLINGS A. P. I.
4 1/2" to 13 3/8" — Long or Short

HYDRAULIC COUPLINGS
1/8" to 4" — Seamless

REAMED AND DRIFTED A. I. S. I.
3/4" to 12" — Seamless

DRIVE PIPE COUPLINGS
6" to 12" — Seamless

WHEELING MACHINE PRODUCTS COMPANY

WHEELING, WEST VIRGINIA

WEST COAST FACTORY: WOODLAKE, CALIFORNIA

X

SALES OFFICES IN LEADING CITIES

Baltimore, Md. — James W. Frankhanel, 2301 N. Charles St.
Chicago, Ill. — Harry A. Jay, Suite 1090, Old Colony Bldg.
Denver, Colo. — W. G. Cline & Co., 4500 Kalamath
Detroit, Mich. — R. W. Lang, Jr., 505 Park Avenue
Erie, Pa. — R. J. Maggi, Box 711
Falmouth, Mass. — Walter S. Bennett, 53 Minot St.
Grand Rapids, Mich. — R. W. Lang, Jr., 138 Burton SE
Houston, Tex. — Henry H. Paris Distributor, Inc., Box 932
Independence, Mo. — Craig A. Frass, 3701 Norwood
Los Angeles, Cal. — James A. Riordan Co., 1400 Santa Fe Ave.
Louisville, Ky. — Sid Schultze Co., 849 S. 6th St.
Milwaukee, Wisc. — W. G. Nelson Co., 3347 N. 97th St.
Narberth, Pa. — Worthington-Grothaus and Associates, 105 Forrest Ave
Newark, N. J. — Ira L. Rothenberg & Assocs., 398 Market St.
New York, N.Y. — Max Rothenberg, 11-05 38th Ave., Long Island City
Omaha, Nebr. — Wm. Freiden, Central States Engineering & Sales Co., 5101 Blonde St.
Oswego, N. Y. — Northeastern Associates, Neil Chatterton, Sec'y, P. O. Box 284
Portland, Ore. — J. G. Beard Co., 1233 NW 12th Ave.
Richmond, Va. — P. C. Abbott & Co., 15 E. Franklin St.
St. Louis, Mo. — Walter C. Dollinger Co., 4869 Goodfellow Ave.
Salt Lake City, Utah — Lovell Company, 29 E. 2nd St. South
Seattle, Wash. — Asho & Jones, 819 Thomas St.

QUALITY-CONTROLLED PIPE COUPLINGS SINCE 1918

Catawissa
PERFECT SEAL
Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

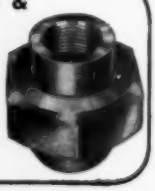
A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!

Standard & Double Extra Heavy
UNIONS
Available with screwed or socket weld ends. 3000-lb. sizes 1/8" to 3"; 6000-lb. sizes 1/8" to 2".

ORIFICE UNIONS
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS
With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS
With screwed or socket weld ends. 3000-lb. and 8000-lb. service.



WRITE FOR CATALOG 58
showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
CATAWISSA, PA.

Trade Parade

Confidence in Future

Confidence in the continued vigor of the oil industry was the keynote for the three day sales meeting held by Continental-Emsco Company in Dallas recently and attended by over 250 Continental-Emsco men from the United States, Canada and South America.

Walter E. Watson, vice chairman of the board and A. S. Glossbrenner, president of The Youngstown Sheet and Tube Company set the tone for the meeting when they expressed their views that there are indications for business to have an upsurge in the near future.

F. M. Mayer, president of Continental-Emsco and vice president of Youngstown, concurred with this view and stated that the oil industry "has been in similar situations in the past and has managed to weather the storms."

Business sessions were conducted by F. I. Brinegar, executive vice president-distributor, Continental-Emsco. The business sessions concerned the various phases of merchandising drilling equipment, production equipment and tubular products.

"The future of the oil and gas industry will depend a great deal upon the development of new tools and techniques," stated W. T. Powell, executive vice president-manufacturing.

Management Conference

With their record of 1957 business volume exceeding that of 1956, the men attending the recent annual management conference of Perforating Guns Atlas Corporation had good reason to plan 1958 operations with confidence.

Paul Charrin, president, said: "During the past 11 years PGAC's annual business has always exceeded each previous year's volume. And despite present clouds hovering over the oil industry, this year will be no exception if the company's forward planning can be carried out successfully.

J. H. Castel, executive vice president, said: "Among the company's recent developments is our new Atlas Bulldog bullet gun, which increases penetration 70 percent over that of our former Atlas guns."

Power Plans for 1958

Stewart & Stevenson Services, Inc. "Power Plans for 58" were unveiled in Houston when more than 100 sales and service representatives of the company met for the annual sales meeting.

Guests at the meeting, under direction of Ross Stewart, chairman of the board, and Joe Manning, general manager, included D. D. Chene of Houston, regional manager for Chrysler Corporation, and Eric Sutton of Dallas, district manager for Detroit Diesel Engines of General Motors.

WRIGHT INDUSTRIAL PRODUCTS of Dallas and Houston, Texas, are new representatives for Librascope computer and controls component products in the states of Texas, Louisiana, Arkansas and Oklahoma. Wright maintains an office at 5738 North Central Expressway, Dallas and 1803 Calumet, Houston 4, Texas. Librascope, Inc. is a subsidiary of General Precision Equipment Corporation, New York.

▸ **Alan Wood Steel Company.** James A. Glunt was appointed chief metallurgist. He was formerly with Jones & Laughlin Steel Corporation.

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Cleveland Room
Dine in the splendid old world setting of a grand dining room. The menu is varied, the service unexcelled.

Bronze Room
One of the brightest of the city's supper clubs. Dancing nightly from 9:00 p.m.
Air conditioned, of course.

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A true specialty restaurant For Fabulous Roast Beef, roasted, carved and served to your order.

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Strictly stag — is this all male haven for good drinks, good food and good talk. Plus sports events on TV.

TRANSIT BAR
For rapid service in the most unique bar in the country . . decorated with an outstanding collection of miniature trains

the PATIO
Pause — in the relaxing, informal atmosphere of the gayly decorated Patio. It's a Cleveland habit to say — "Meet me at the Patio."

Coffee Shop
Service is brisk and decor cheerful in the modern, air-conditioned coffee shop. Enjoy a tasty sandwich or a moderately priced meal.

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CLEVELAND, OHIO
WRITE OR CALL FOR YOUR RESERVATIONS NOW

Here's Refrigeration Designed For Every Basic Oilfield Application!

...It's The New BS&B "COLD-FRAC*" Ammonia Absorption Refrigeration Unit

OUTSTANDING FEATURES:

1. **Entirely Self-Operating.** Automatically Adjusts to Load Changes.
2. **Low Initial Cost.** Unit May Be Skid-Mounted Except Ammonia Reboiler. Outside Construction — No Buildings Required.
3. **Low Cost Maintenance.** Liquid Pump Is The Only Moving Part.
4. **Operating Costs Vary.** In Direct Proportion To The Load.
5. **Lower Operating Temperatures** Do Not Materially Decrease Capacity.
6. **Completely Closed System.**
7. **Chiller "Slop Over" Of Liquid Refrigerant Causes No Problem.** (There is no compressor to cause worry about liquids in the suction.)
8. **Oil Lubrication Eliminated.** No Oil-Refrigerant Problem.
9. **Vibration Free.** No High Speed Reciprocating Machinery To Mount.
10. **Experts Are Not Required** To Operate and Maintain The Unit.

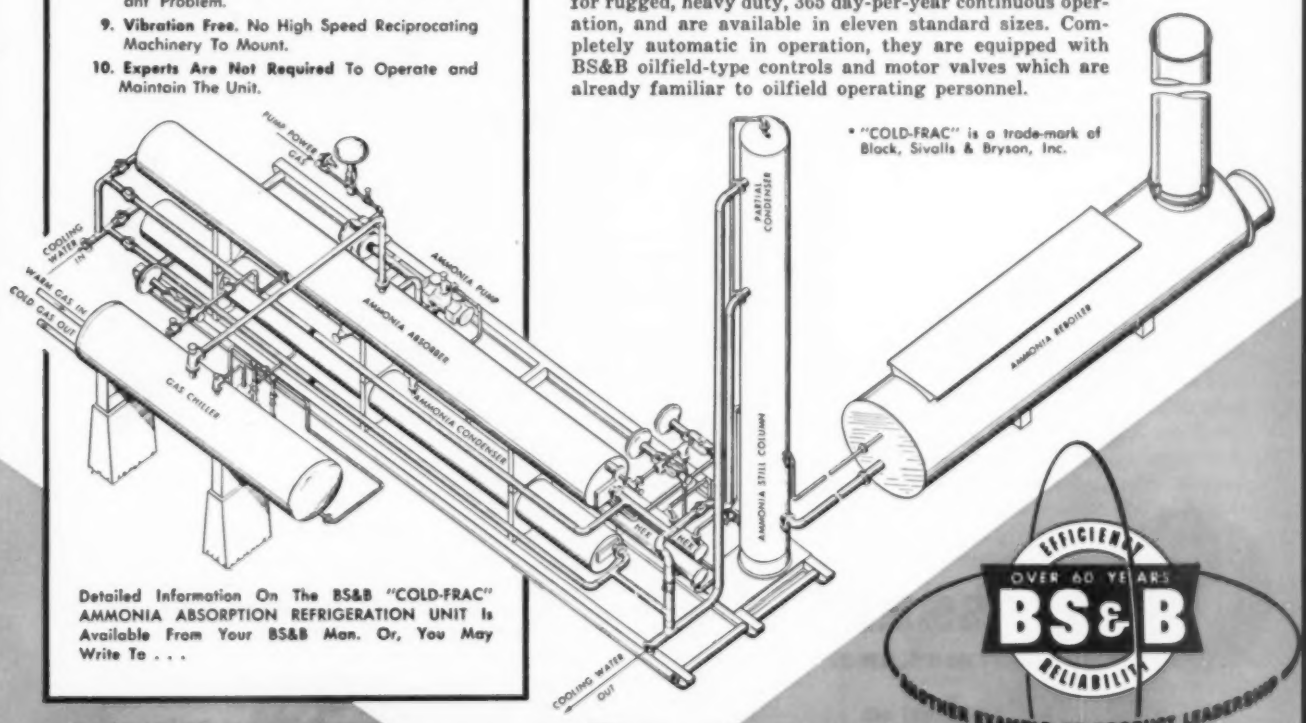
Detailed Information On The BS&B "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION UNIT Is Available From Your BS&B Man. Or, You May Write To . . .

With the development of BS&B's new "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION Unit, the oil industry now has a simple, non-mechanical, heavy duty artificial refrigeration system which is applicable to any oilfield or refining process requiring temperatures below ordinary atmospheric level.

A few examples of immediate industry applications are:

1. **Gas Pipeline Companies — For The Elimination Of Liquids In Gas Transmission Lines Through Better Hydrocarbon Dewpoint Control.**
2. **Gasoline Plants — For The Chilling Of Absorption Oil To Increase Hydrocarbon Recoveries Without Installing Larger Absorption Oil Towers Or Pumps.**
3. **Lease Production — To Provide Essential Refrigeration For Maximum Hydrocarbon Recovery Where Sufficient Pressure Expansion Is Not Available. Also To Supplement Declining "Natural" Refrigeration.**

These Ammonia Absorption Refrigeration Units are built for rugged, heavy duty, 365 day-per-year continuous operation, and are available in eleven standard sizes. Completely automatic in operation, they are equipped with BS&B oilfield-type controls and motor valves which are already familiar to oilfield operating personnel.



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EFFICIENCY OVER 60 YEARS BS&B RELIABILITY
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CLARK BROS. CO.—*compressors* • **DRESSER-IDECO COMPANY**—*steel structures* **DRESSER MANUFACTURING DIVISION**—*couplings* • **THE GUIBERSON CORPORATION**—*oil tools* • **IDECO, INC.**—*drilling rigs* • **LANE-WELLS COMPANY**—*technical oilfield services* • **MAGNET COVE BARIUM CORPORATION**—*drilling mud* • **PACIFIC PUMPS, INCORPORATED**—*pumps* • **ROOTS-CONNERSVILLE BLOWER DIVISION**—*blowers* • **SECURITY ENGINEERING DIVISION**—*drilling bits* **SOUTHWESTERN INDUSTRIAL ELECTRONICS**—*electronic instrumentation* **WELL SURVEYS, INC.**—*nuclear and electronic research and development.*

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PROTECT & SEAL THREADED FITTINGS

Apply LED-PLATE Sealing & Anti-Seize Compound

Recommended for HYDRAULIC FITTINGS will not plug orifices

FAST ASSEMBLY
No cross threads
Tight with less torque
Lead is a thread tube.

A REAL PIPE SEALER
Pressure hold 20,000 psi up Liquid or Gas

U.L. approved for butane, propane, gasoline, petroleum.

Use for: Hydraulic fluids, steam, ammonia, etc.

NO HEAT FREEZE
Temperature range—100° to 2987° F.

NO CORROSION WELD
Stops rusting, acid-etch and corrosion.

NO GALLING OR SEIZING
Recommended for aluminum, stainless, titanium, plastic, steel, brass, etc.

EASY DISASSEMBLY ANYTIME
Better than new threads.

— for
STUDS, BOLTS, GASKETS
AIRCRAFT PLUMBING
AUTOS MARINE
OIL WELLS PIPING

(No. 250)

Stocked by Supply and Hardware Stores

Ask for FREE SAMPLE

ARMITE LABORATORIES
6609 Broad Street Los Angeles 1, Calif.

BUCYRUS-ERIE Company in April transferred most of its drill division activities from South Milwaukee to its new plant in Richmond, Indiana. Construction of the plant was completed recently. The South Milwaukee plant will discontinue stocking and mounting drills, parts service and bit dressing. It will continue repair service for both drilling and fishing tools.

K. L. BOURDO Company, oil field supply sales and service organization with headquarters in Beirut, Lebanon, has established offices in Tripoli, Libya, with Wesley Bourdo as manager. The Bourdo Company handles Ideco sales and service in the Middle and Near East and Northeast Africa. The offices are located at 21 Sciara Carracci, Tripoli. Prior to opening the offices in Tripoli, Wesley Bourdo was with the Santa Fe Drilling Company in California and Trinidad.

BRIGGS-WEAVER Machinery Company was appointed dealer for Schramm, Inc., in the Dallas-Fort Worth area to handle sales, servicing and rental of portable and stationary air compressors, the Schramm pneumatractor and pneumatic construction tools. In Dallas Briggs Weaver is at 5000 Hines Boulevard and in Fort Worth at 222 North University Drive.

ONE OF AMERICA'S large diversified chemical companies doing business since 1920 as Aliled Chemical & Dye Corporation is about to become simply Allied Chemical Corporation.

The recommendation will require the affirmative vote of the holders of a majority of the outstanding common stock of the company and if approved will become effective by May 1.

NON-SPARKING

NEW LUFKIN "JET" TAPE

Here's the non-sparking tape the oil industry needs for jet fuels. Stainless steel line is Chrome Clad®. The handle is wood. All other parts are non-sparking metals. See your dealer for this new Lufkin oil gaging tape.

THE LUFKIN RULE COMPANY
TAPES • RULES • PRECISION TOOLS
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FAN tas tic

Aeromaster FANS

increase cooling tower efficiency with MORE CFM and LESS HP

Precision engineered Aeromaster Fans with variable pitch blades and anti-flutter design give cooling at *lower cost*. Blades resist acids, alkalies, abrasion and weather. 4, 6 or 8 blade styles in 54" to 22' diameters. Before you replace or consider new equipment, write: KOPPERS COMPANY, INC., 6705 Scott Street, Baltimore 3, Md.

KOPPERS Aeromaster Fans

Engineered Products Sold with Service

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

GPE — technological bumbershoot

Covering the advanced needs of industry and defense is today's biggest technological job.

GPE has brought together, under one umbrella, broad physical resources plus a remarkably creative group of scientists, engineers and technicians. Its co-ordinated skills, knowledge, experience and producing facilities cover more than a dozen industries.

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Address inquiries to:
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92 GOLD STREET, NEW YORK 38, N. Y.

Infilco Inc. Thomas P. Hutchinson was named representative of Infilco (Canada) Ltd. in eastern Ontario, Quebec and the Maritime Provinces. He will have his headquarters in Montreal.

Ingersoll Kalamazoo Division Borg-Warner Corporation. A. M. Klinger has been named sales manager of materials handling products.

Walworth Company. The appointment of R. F. Fred Klein as manager of lubricated plug valve sales was announced. Prior to his appointment, Klein was a sales engineer in the company's metropolitan division, specializing in sales to the gas distribution industry.

Welex, Inc. P. A. Wagstaff has been named division manager of the newly organized Kansas division. The Kansas division includes districts in Great Bend with H. L. Kendall as manager, Hays with J. W. Pickering as manager, Pratt with C. P. Stewart as manager, Winfield with L. M. Bullock as manager, Crossville (Illinois) with J. J. Weathers in charge and Salem (Illinois) with L. G. Harris in charge.

Other Kansas division personnel include W. B. Clark, assistant division manager; Jack Wheeler, division sales manager; and R. H. Mallett Jr., division sales engineer.

Win-Well Manufacturing Company. Victor L. Lewis was named sales manager. He will supervise sales development on the 7-way multiport selector valve. Lewis is a veteran of 15 years in the production equipment sales field, having served with the Emsco Manufacturing Company office in its Great Bend, Kansas; Snider, Texas; and Healdton, Seminole and Tulsa offices; and with the Oklahoma City store for Bethlehem Supply Company.

Wright Chemical Corporation. Dr. Rosemarie Meyer has joined Wright's research department staff as a microbiologist. Dr. Meyer received her PhD from the Illinois Institute of Technology in microbiology with a minor in biochemistry and statistics.

United States Steel Corporation. Joseph P. Deroche was named Oil Well Supply Division field representative at Houma, Louisiana. D. L. Whatley was made city representative at Wichita Falls, Texas for "Oilwell." Herman H. Walker is appointed field representative in Houston.

J. W. (Bill) Breeden, formerly wire rope salesman at Odessa, Texas, was made manager of sales, Dallas district sales, for American Steel & Wire Division. He succeeds B. M. Ashbaucher who has been named district sales manager at Chicago.

Dresser Industries, Inc. Named to the board were the following directors: H. N. Mallon, chairman; Norman Chandler, Los Angeles, president and publisher, The Los Angeles Times; Henry P. Isham, Chicago, president of the Clearing Industrial District, Inc.; Willard M. Johnson, Houston, president of the Magnet Cove Barium Corporation; John Lawrence, Dallas, executive vice president (Dresser Industries, Inc.); L. W. MacNaughton, Dallas, board chairman, DeGolyer & MacNaughton; William A. McAfee, Cleveland, senior partner, McAfee, Grossman, Taplin, Hanning, Newcomer & Hazlett; J. B. O'Connor, Dallas, president (Dresser Industries, Inc.); R. E. Reimer, Dallas, executive vice president, (Dresser Industries, Inc.); Tom Slick, San Antonio, chairman, Slick-Moorman Oil Corporation.

Fuller Company. Russell Hawk, advertising manager for the last 22 years, has retired. Robert F. Miller, who joined Fuller in March 1954, as assistant advertising manager, replaces him.

Gardner-Denver Company. Richard J. Bauer, regional manager of the oil field division was elected a vice president.

General Electric Company. Harlan M. Thorpe was appointed manager—quality control in GE's medium steam turbine, generator and gear department.

DRILCO ADDS PORTABLE magnaflux unit at Shreveport, Louisiana, to increase its service for complete inspection of drill collars. V. V. (Joe) Hibler, left, assistant sales manager for Drilco Oil Tools, Inc., Midland, Texas, discusses the new inspection unit with Zane Duff, Drilco's inspector for the Ark-La-Tex area. Unit can locate at the rig badly cracked connections, minor cracks, stretched pins or swelled boxes.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

40% MORE 40% WATER

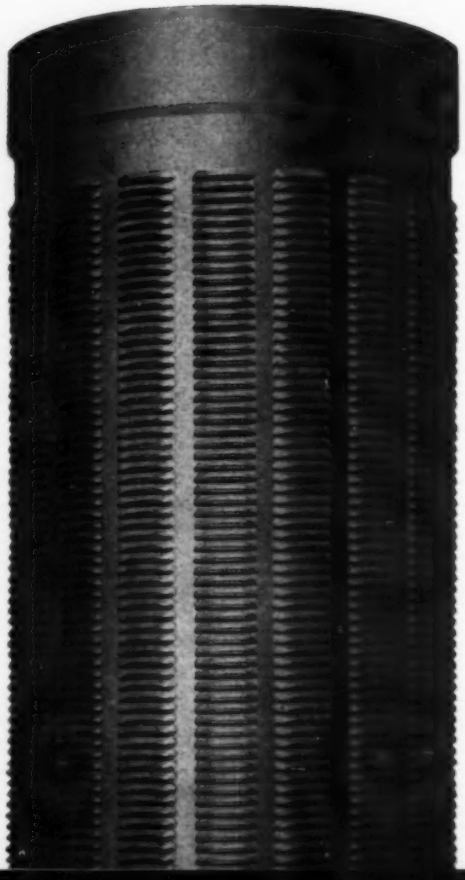
can flow through the NEW Layne 134 shutter screen

WHY? *Increased inlet area!*

Here's a screen that is even more efficient . . . has *greater strength* than the long-lasting Layne 96 shutter screen that made Layne water wells famous.

This new development of Layne creative research is used only in Layne water well installations, and available exclusively through Layne Associate Companies.

Contact your nearest Layne Associate Company for complete details.



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Layne Associate Companies throughout the world.

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VERTICAL TURBINE PUMPS • WATER TREATMENT

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LOUISIANA WELL COMPANY
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LAYNE-NEW YORK COMPANY
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LAYNE-WESTERN COMPANY
Kansas City, Missouri
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Aurora, Illinois
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Omaha, Nebraska
Wichita, Kansas
Denver, Colorado

CANADA

INTERNATIONAL WATER SUPPLY, LTD.
London, Ontario, Canada
Oakville, Ontario, Canada
Montreal, Quebec, Canada
Quebec, Quebec, Canada
Saskatoon, Saskatchewan, Canada
Vancouver, B.C., Canada

▸ **Merkle-Korff Gear Company.** John D. Simms, assistant vice president, who has directed factory operations for the last 2 years, assumes administrative duties relating to sales. Robert J. Marlatte, as plant manager, fills the post vacated by Simms. Marlatte, formerly vice president in charge of manufacturing and engineering of the Production Instrument Company of Chicago, was with that company for 18 years. Ray Schroeder comes to the newly created post of service engineer.

▸ **Midcontinent Tube Service, Inc.** Harold Michel was appointed vice president in charge of sales of the newly formed Midco Valve & Fittings, Inc., Evanston, Illinois. Michel has been a member of the parent company, Midcontinent Tube Service for the past 3 years.

▸ **Otis Engineering Company.** Dick M. Koons, former senior production engineer for Cia Shell de Venezuela in Maracaibo, has joined Otis Engineering as a development engineer.

▸ **Motorola, Inc.** Harry Ronan has been named manager, two-way radio sales, a new position, for the 15-state eastern area reporting to Lowell White, vice president and eastern area manager of Motorola Communications and Electronics, Inc.

Replacing Ronan as New England regional sales manager is Ed Vogel, who has been a zone manager there.

Named to two new special sales posts are Pat Kelly and Bob Swift, who had been sales engineering administrators in the eastern and midwest areas respectively. Kelly is now account executive manager, eastern area, and Swift is sales manager, special markets, in the midwest.

▸ **Petrolite Corporation.** Recent additions to Tretolite Company's staff of field engineers include: Conrad P. Lozano, to field service engineer at Odessa. Frank J. Ortt becomes a representative at Estevan, Saskatchewan, Canada. James H. Roberson Jr. has been assigned the Casper, Wyoming, district and Robert E. Morgan has joined Tretolite as service engineer for the San Antonio, Texas, district.

Lester O. Eime, research chemist for Alcoa Research Laboratories, East St. Louis, Illinois, for the past 10 years, has joined Petrolite as a research chemist in the company's laboratory, Webster Groves, Missouri.

Roy W. Greenlee, formerly a consultant with the organic chemistry division of Battelle Memorial Institute, also has joined the research staff of Petrolite.

Ed L. Dressel, of the Tretolite Company division of Petrolite development laboratory in St. Louis, Missouri, has been assigned to head the company's new field service laboratory recently completed at Odessa, Texas.

▸ **Schlumberger Well Surveying Corporation.** D. G. Davis, formerly senior sales engineer in Denver, was named manager at Cody, Wyoming. H. T. Carson, formerly manager at Falfurrias, Texas, is now stationed in Alice as station manager. F. A. Rice has been transferred from Alice to Falfurrias as manager.

The former manager of the perforating ing location at Farmington, New Mexico, J. L. Hallman, has been transferred to Denver as senior sales engineer. Don Fitzgerald, sales engineer in Houston for a time, continues in the sales field in Wharton, Texas. W. B. Jackson, sales engineer, has been transferred from Houston to Beaumont.

▸ **Leschen Wire Rope Division, H. K. Porter Company, Inc.** William C. Germo has been appointed sales representative. His territory will cover northern Illinois and southern Wisconsin except the Chicago metropolitan area.

▸ **L. Sonneborn Sons, Inc.** Dr. Ira Kukin was made research director at the Belleville, New Jersey, plant. In this capacity he will be in charge of research and development on petroleum and textile products for the company.

▸ **Union Carbide Chemicals Company.** Richard W. Eddy has been promoted to the position of manager, new chemicals division. He had been assistant manager of this department since 1955.

▸ **Master Tank & Welding Company.** Ed Stafford was appointed sales representative, headquartering in Dallas.

▸ **Alten Foundry and Machine Works.** Taldon "Tillie" Manton was named oil field representative in Fort Worth, Dallas and northern Texas. He will handle the firm's line of pumping units.

▸ **Athey Products Corporation.** William D. Lease was elected to the board of directors and elected executive vice president of the corporation. He was formerly vice president of sales.

▸ **Babcock and Wilcox.** Leslie S. Wilcoxson was elected a member of the board of directors of Babcock-Wilcox & Goldie-McCulloch Ltd. in Canada. He is vice president in charge of the boiler division and a director of The Babcock & Wilcox Company, of the U. S.

▸ **Baroid Division National Lead Company.** Edward Z. Walden was named export sales representative with offices at 111 Broadway, New York City. He will work in a dual capacity, serving also as sales engineer for Baroid Chemicals, Inc., in the New York district. Ralph A. Wall was appointed assistant advertising manager.

▸ **Barrett Division, Allied Chemical & Dye Corporation.** Warren M. Rappley was named assistant manager, paving material sales, Chicago district. D. A. Mitchell and W. D. Labaugh were promoted to district managers of industrial tar products sales. Mitchell will cover the western part of the USA, with headquarters in Chicago. Labaugh will handle sales in the eastern part of the country, with offices in New York City.

▸ **Barton Instrument Corporation.** A. I. Thompson, formerly vice president and sales manager was appointed vice president in charge of sales; Claude B. Nolte to vice president in charge of product engineering and development; Everette M. Furr was made factory superintendent, and William S. Christian was named sales manager.

▸ **Beckman Instruments, Inc.** Announce the opening of new field offices in Houston, Texas, and the appointment of John H. Gibbs as field engineer of Beckman/Systems Division in Houston.

▸ **BJ Electronics, Borg-Warner Corporation.** David Oglesby was named company engineering representative to East North Central states.

▸ **Blaw-Knox Company.** John P. Wilson was named eastern manager of petroleum sales for the chemical plants division. His headquarters will be in the New York City offices, and he will be responsible for petroleum enginering sales along the eastern seaboard.

▸ **Brooks Rotameter Company.** Richard P. Homiller was appointed applications engineer. He was formerly with Imperial Chemical Industries Ltd.

NOT EVEN FIVE FEET OF PEAT BOG CAN HANG UP THE NO. 583

The Cat* No. 583 Pipelayer is not only the highest capacity pipelayer in history—but the most efficient. Mannix Ltd., Calgary, Alberta, has four of them in its 100% Caterpillar spread laying 110 miles of 30-inch gas line through southern British Columbia.

The line takes the No. 583s through 40 miles of reclaimed lake bottom, covered with heavy silt and peat bog four to six feet deep. But the No. 583 has a full 21-inch ground clearance, and the bog can't stop it.

These big yellow units were engineered to give you a full day's work no matter what the terrain. For this machine was designed after consulting spread superintendents, foremen, mechanics and operators throughout the industry. It incorporates all their ideas of the ideal pipelayer. As a result you have the first machine that is *all pipelayer*.

It has 130,000-lb. lifting capacity and its engine delivers 191 HP. There is a three-stage torque converter in the main drive and new hydraulically actuated counterweights. And the extra high bottom clearance of the counterweight pivot, coupled with the ability to retract the counterweights well over the tracks, means that the No. 583 can maneuver easily even while handling an extra heavy load on a narrow right of way.

Here's the safest, fastest, most efficient machine ever designed for pipelaying. Behind it stand an army of Caterpillar Dealers always ready to give you quick service with quality factory parts wherever the pipe takes you. Call your Caterpillar Dealer today. You name the date—and he will demonstrate on *your* job.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

WANTED—
THE HARD WORK

Two New Stores Opened

The National Supply Company has opened two new oil field supply stores and modernized another. New stores are at Charlson, North Dakota, and near Leeville, Louisiana. William S. Dagg is manager in the North Dakota area. The store is supervised by J. D. McClintick, district manager of the company's Montana district. The Leeville store, on Highway No. 1, between Golden Meadow and Grand Isle, will serve land and offshore operators. Leroy W. Snell Jr., is store manager, under supervision of L. A. J. Monroe, district manager, New Orleans.

National Supply completely modernized its store at Oklahoma City, in use since 1929. The building was remodeled under the company's moderization program, according to plans by Henry Dreyfuss, noted industrial designer. At present National Supply operates 131 stores in the United States, Canada, and Venezuela.

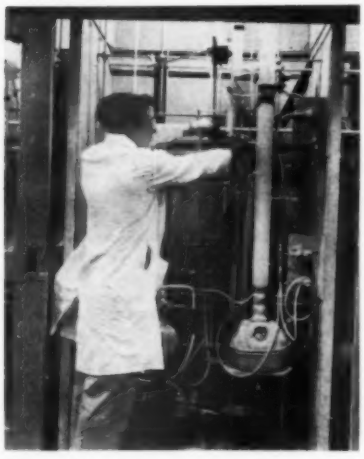
Wayne Showalter is store manager, under supervision of W. M. Jones, Oklahoma City district manager.

A DISTRICT SALES office at Kansas City, Missouri, was opened by Chicago Bridge & Iron Company, which has 16 similar offices throughout the United States.

Sales manager of the new office is Theodore F. Cocks, who has been affiliated with the company for six years. He was a member of the Chicago district sales office prior to moving to Kansas City and earlier worked in CB&I offices at Salt Lake City, Utah, and Birmingham, Alabama.

A MANUFACTURING PLANT to keep pace with the rapidly changing semiconductor industry was recently put in operation by the Westinghouse Electric Corporation. The plant, near Youngwood, Pennsylvania, is the result of the company's decision to enter the field of semiconductor devices primarily for power applications.

Photo shows part of the pilot facility at the plant to produce ultrapure silicon



by the Siemens process. This process was recently developed by the Siemens Schuckertwerke and Siemens-Halske Companies in Germany in conjunction with work done by Westinghouse.

PLANT WIDE EXPANSION program of the Vapor Recovery Systems Company, 2820 North Alameda, Compton, California, has been completed. The electro-mechanical department has been doubled in size and a complete new and modern testing and development laboratory has been added to expedite completion of the many new products under study. The engineering department has been enlarged to accommodate almost double its former capacity of engineers. General offices have been enlarged and new offices added for the Sales, Advertising and Accounting departments.

Additional factory expansion is contemplated with completion scheduled for late 1958.

CHICAGO SALES OFFICE and warehouse of The Lunkenheimer Company, Cincinnati, Ohio, valve manufacturer, have been moved to 1500 South Western Avenue.

The new office and warehouse will serve a growing number of Lunkenheimer customers in the Northern Illinois and Northern Indiana area. In addition to the Chicago office, the firm maintains branches in Boston, New York, and Philadelphia.

A NEW SERVICE OFFICE and warehouse has been established by Axelson Manufacturing Company, a division of U. S. Industries, Inc. The offices are at 1231 West Cowles, Long Beach, California.

SALE OF CERTAIN ASSETS of Micromatic's Micro-Precision Division in Evanston, Illinois, to Allis-Chalmers was announced. Allis-Chalmers has acquired all the machinery, equipment, inventories and patents relating to the diesel operation. All elements in the purchase will be transferred to the Allis-Chalmers plant in Harvey, Illinois.

Over One Million Feet of...

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HIGH-IMPACT

PVC PIPE

in oil-country use today

This proves that there is no substitute for Kraloy experience.

KRALOY is the most experienced manufacturer of PVC plastic pipe for the petroleum industry. The first polyvinyl chloride lead line installed in this country—at Great Bend, Kansas—was Kraloy Pipe. Kraloy High-Impact PVC today is preferred by production men for maintenance-free service in lead lines and disposal systems. Kraloy customers use Kraloy High-Impact PVC pipe for lead lines, gas lines, and salt water lines because Kraloy normally eliminates (1) sulphur corrosion due to sour crude, (2) paraffin buildup, (3) corrosion and scale, (4) trouble from soil electrolysis.

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To insure quality control, random samples of Kraloy Plastic Pipe are tested daily in Kraloy's own laboratory for burst pressure, impact resistance, and tensile strength under standard ASTM specifications.

Kraloy Pipe is Sold Only Through Qualified Supply Stores

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N. Y. 20, N. Y.

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DALLAS 30, TEXAS

The Mack Company, 2005 Hackney St.
HOUSTON 23, TEXAS

Ross Howell, 209 E. Scott St.
WICHITA FALLS, TEXAS

The Becker Sales Company, P. O. Box 2262
TULSA, OKLAHOMA

The Becker Sales Company, 716 S. 29th St.
OKLAHOMA CITY, OKLAHOMA

Robinson Oil Field Specialties, 616 Main St.
GREAT BEND, KANSAS

For Detailed Information, Write Dept. PE-58

KRALOY *plastic pipe co., inc.*

4720 East Washington Boulevard, Los Angeles, Calif.

Subsidiary of the Seamless Rubber Co., a Rexall Drug Co. Subsidiary

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A Guide to Books

Management for Engineers, *by Roger C. Heimer, published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36, New York. Pages, 453. Price, $6.75.*

Engineers who want to proceed from professional to managerial positions will find this a good basic textbook. The author, associate professor of mechanical engineering, Villanova University, reviews the background of his engineer readers before going into various phases of management. Only recently has engineering received some of the respect that has long been paid to other professions. Now the complicated technology of business is forcing the engineer into management.

Professor Heimer covers laws, finances, insurance, inventory, standards, labor, organization, decision-making, etc.

Oil Reservoir Engineering, *by Sylvain J. Pirson. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. Pages, 733. Price, $14.*

This is the second edition of an industry-accepted text that first appeared in 1950. It is, however, for all practical purposes a new book, in that only about one-third of the original material appears in this edition. New material includes complete rewriting of sections on logging and logging interpretation, a new chapter on fluid flow in porous media, a new chapter on fundamental oil recovery mechanisms, and a chapter presenting a unified theory of oil reservoir engineering. The author presents the material balance equation in finite difference form so that reservoir engineering problems may be computed using only a slide rule.

Fundamentals of Mechanical Design, *by Richard M. Phelan, published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. Pages, 526. Price, $8.75.*

Title of this text is a bit misleading for mechanical engineers in the process, pipelining, or production phases of the petroleum industry. The text deals more or less specifically with design of machinery, with chapters devoted to couplings, clutches, various types of drives, gears and gear trains, bearings and lubrication, and vibrations in machinery. Being rather specific, engineers concerned with design and installation of motors, pumps, compressors, etc., may find the material of value when facing fundamental design problems.

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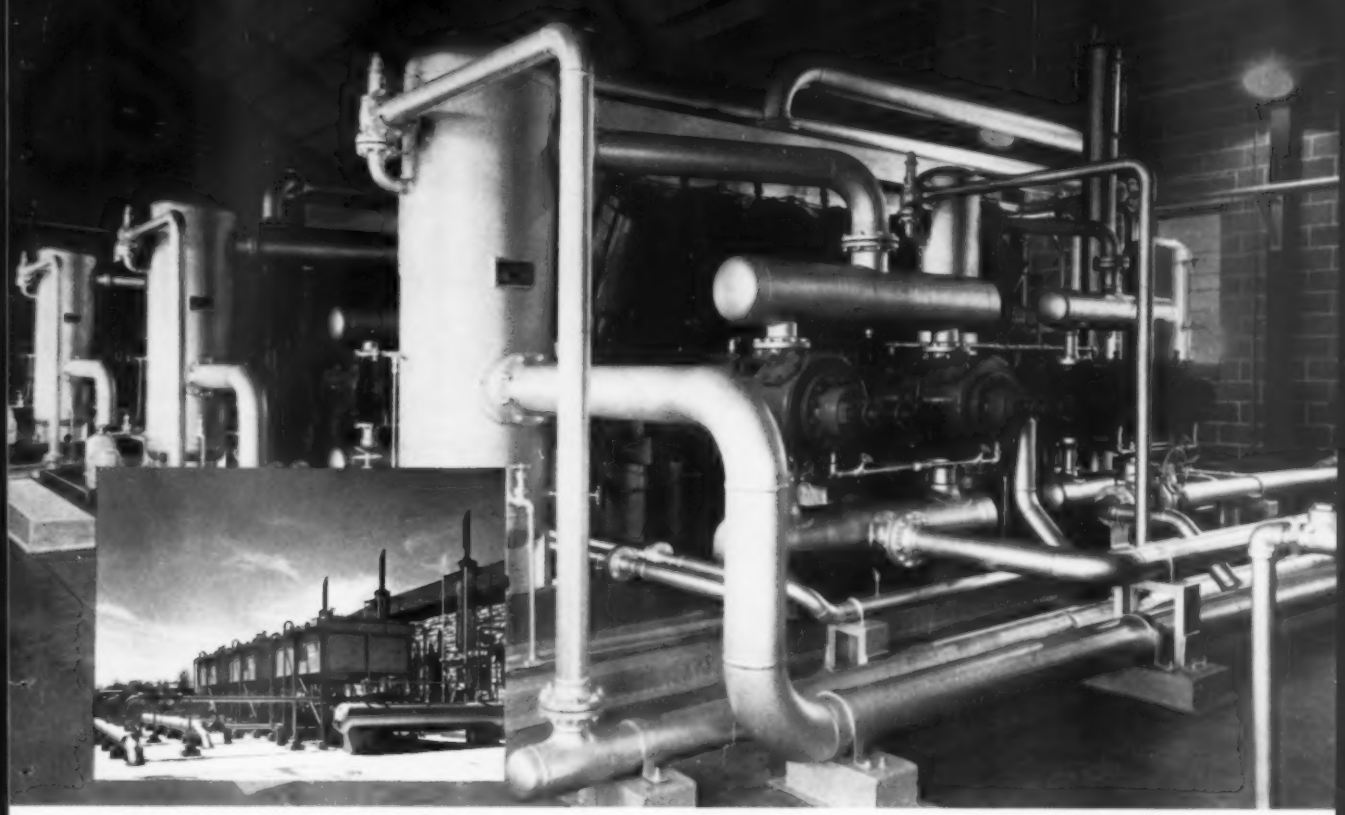
BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



Horizontal radiators are cooled by hydraulic motor driven fans powered by pumps V-belted to sheaves on the end of each engine crankshaft.

Laclede Gas Company's Gas Storage Project—equipped with three Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors. Units have Young radiators with gas, lubricating oil and engine water cooling sections. Other Beaird compressors from 120 to 660 h.p.

PACKAGED COMPRESSORS STORE WINTER'S RESERVE GAS SUPPLY FOR ST. LOUIS

IN ONE of the largest and most successful projects of its type, Laclede Gas Company of St. Louis is pumping billions of cubic feet of natural gas into sandstone that never held gas before. This additional supply will meet peak load demands enabling the company to heat additional thousands of St. Louis homes this winter.

Three Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors are taking up to 16 MMcfd, delivered by pipeline from Louisiana, compressing it through two stages from 50 to 125 psi. suction to 655 psi. discharge. The gas is injected down 1400-1500 foot wells into a natural sandstone reservoir bed.

Gas interstage and after cooling is provided in sections of the horizontal radiators mounted outside the compressor building. Use of electric motors to drive auxiliary equipment has been eliminated wherever possible. Pumps for engine cooling water, lubricating oil and radiator hydraulic fan motors are all driven off the compressor.

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—M. J. Rathbone, President, Standard Oil Company (New Jersey)

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Automation is the key word in more efficient and progressive management today. And when you think of *automation* you must associate it immediately with UTILITY ELECTRIC POWER. Only UTILITY ELECTRIC POWER provides the complete, fully automatic features of automation in oil field production. The evidence is so impressive in favor of UTILITY ELECTRIC POWER that all companies – who consider themselves progressive – will want to know how they can benefit from this modern, efficient power. Call the sales engineer of your Utility Electric Service Company for complete facts.

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Speeds oil field construction, maintenance, material-handling

Next time you need a good, heavy-duty crawler crane for heavy lifting around refineries, yards, booster stations, drill sites, check what this Koehring 305 will do for you. It safely lifts up to 15 tons. That's based on conservative 75% rating. Butt-connected boom can be extended from 35 to 80 feet. Inserts are safe, solid — easily changed — only 2 bolts per corner. When extra reach is needed, the Koehring 305 handles 15 to 20-foot jib on 80-foot boom — raises maximum 100-foot boom and jib with low A-frame!

Heavy lift capacity and stability increase the 305's work capacity with all attachments — it handles ¾ to 1-yard clamshell or dragline buckets on wide work radius — readily converts to pile driver, ¾-yard shovel or hoe. Here are some important features that help you get more work done with every attachment:

Heavy-duty 305 has independent traction (optional) — self-cleaning crawlers with heat-treated cast-steel shoes, multiple-hinge joints and full-length pins. Crawler traction brakes are automatically engaged at all times, until tractive power is applied — lock and hold the 305 when working or parked. Koehring power clutch also simplifies operation — gives 90% power-assist for light lever pull — yet, retains sensitive "feel" of load. Maintenance is simplified, too. There are only 2 main shafts in the 305's upper machinery. Each assembly is an independent unit with fully-enclosed gears, and splined shafts rotating on anti-friction bearings.

This 305 is also available on rubber, as a 25-ton truck crane with all standard attachments. See Koehring distributor for details, or write today.

mail to:

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Send us ☐ *spec. sheets* ☐ *bulletin on Koehring 305*

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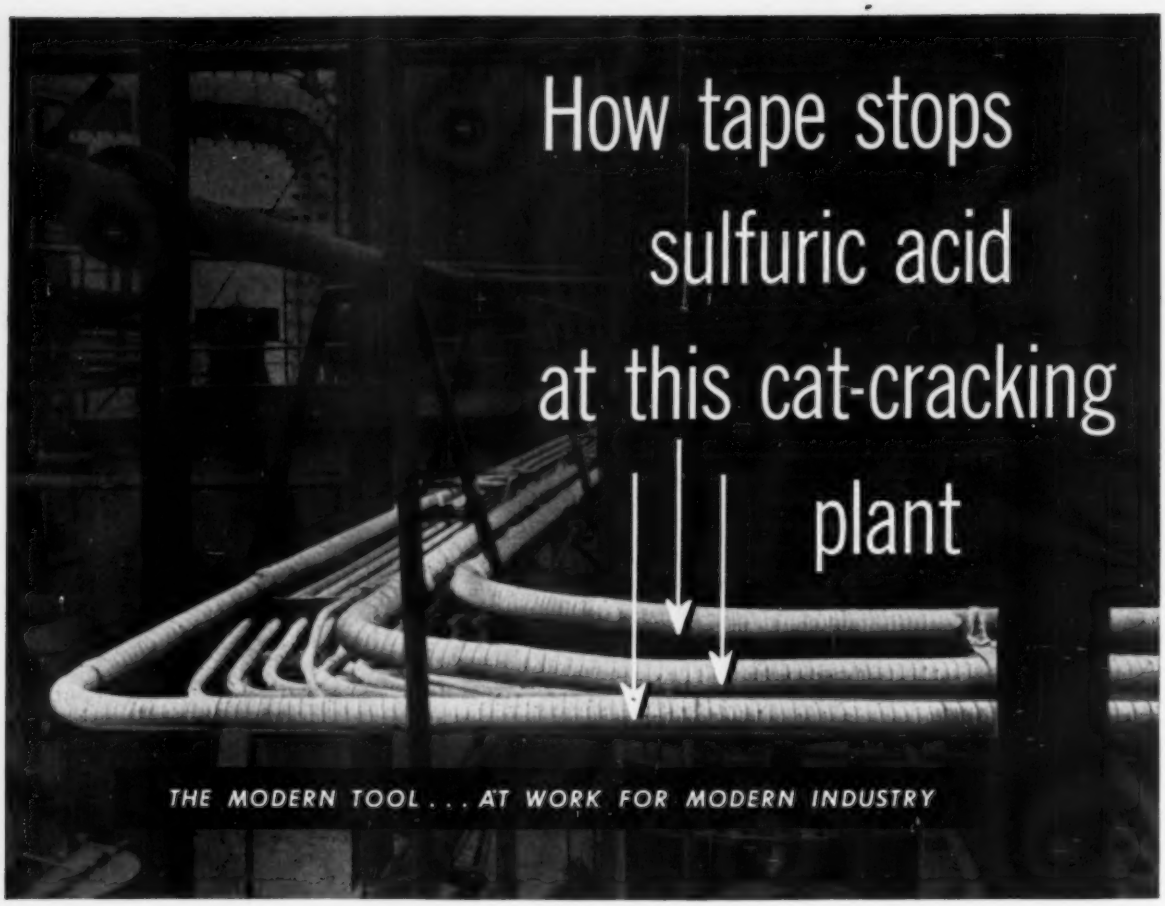

FIVE YEARS UNDER THESE HIGHLY CORROSIVE CONDITIONS PROVES THAT POLYKEN PROTECTION WORKS . . . *TO TRIM COSTS*

Look in on one of the world's largest fluid catalytic cracking units. A maze of conduit and pipe exposed to an extremely corrosive sulfuric acid atmosphere.

Formerly, these structures had to be painted every three or four months. Maintenance costs were excessive. Then, five years ago, they were wrapped with Polyken Protective Tape Coating. They have needed practically no attention since.

INERT POLYETHYLENE

The reason is that Polyken takes amazingly inert polyethylene and makes it into a tape coating with all these properties.

- **tough and elastic**
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- **far higher adhesion for a true bond to pipe surface**
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- **higher electrical insulation resistance**
- **better cold weather handling and durability**

Check the savings. Contact the Polyken distributor in your area.

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Long Beach, Calif.: Barnes & Delaney
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Plainfield, New Jersey: Stuart Steel Protection Corp.
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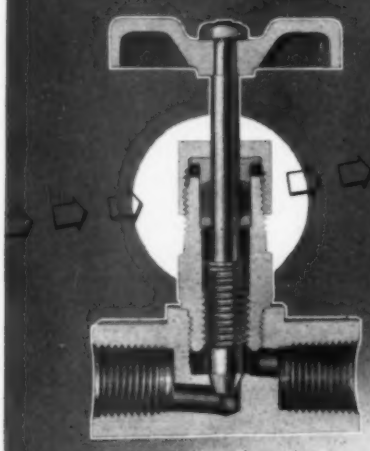
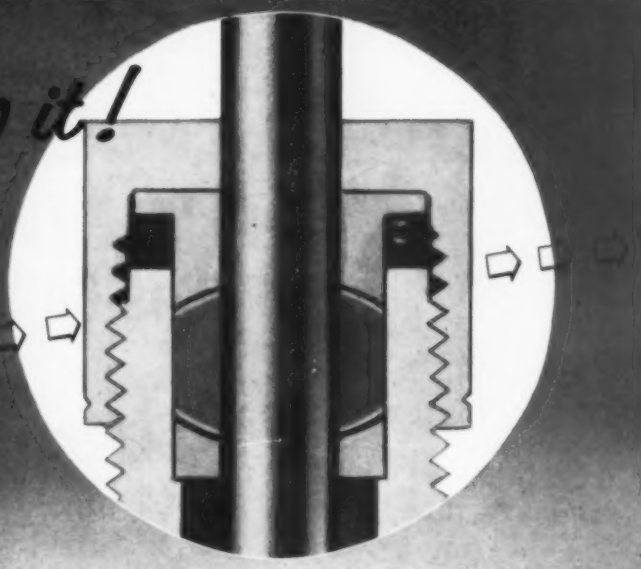




The Marpak Packing System

—*now with fabulous*

"TEFLON" PACKING

An outstanding feature of the Marsh Needle Valve has been the Marpak Packing System. This unique method of obtaining a tight, but non-binding seal is one of the important reasons for the ability of Marsh Valves to give precision regulation at any pressure up to 10,000 psi.

Now the Marpak system has been made still better by the use of today's miracle material—"Teflon." You probably know of the almost incredible toughness, resilience and non-adhesive properties of Teflon—properties that are unimpaired by the most powerful of solvents, acids, or alkalies, even at temperatures up to 500° F.! As a result of incorporating "Teflon" packing, Marsh Stainless Steel Needle Valves are now

Guaranteed for any pressure up to 10,000 psi at any temperature up to 500° F.

In other makes of valves permissable temperature *decreases* as pressure *increases*—but not with Marsh.

Teflon packing is one more addition to the list of features that are combined only in Marsh Stainless Steel Needle Throttling Valves. Note the list opposite...ask for bulletin.

Available in

MARSH

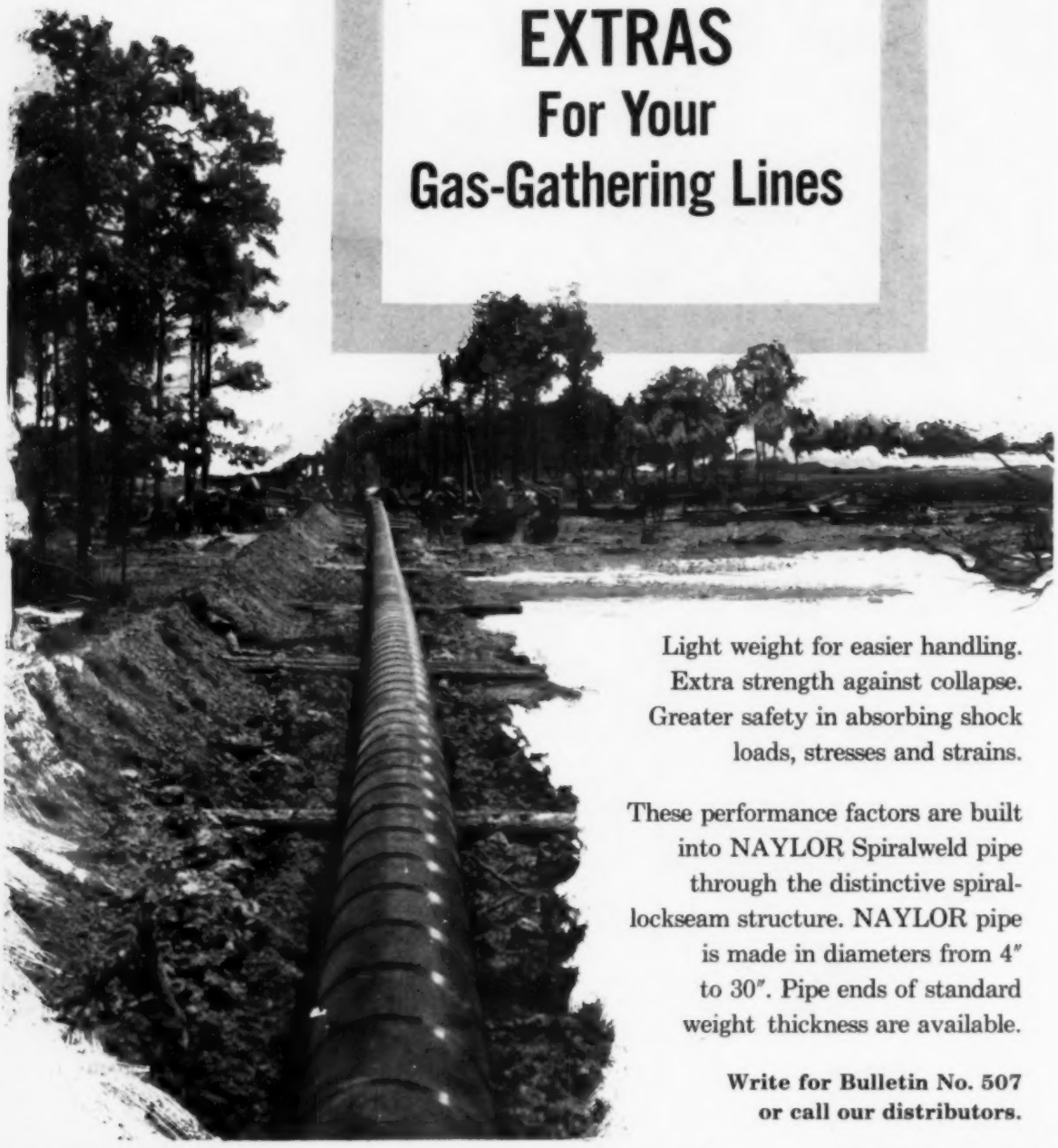
416 Stainless Steel

Needle Throttling Valves

- **Body and stem guide machined from bar stainless steel stock**
- **Valve Stem hardened stainless**
- **Fine stem threads for extra strength and precision throttling**
- **Deeper inlet and outlet chambers**
- **Bodies made in accordance with MSS regulations**
- **Packing "Marpak" system incorporating "Teflon" as described opposite**

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.*, **Dept. M Skokie, Ill.**
Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

EXTRAS
For Your Gas-Gathering Lines



Light weight for easier handling. Extra strength against collapse. Greater safety in absorbing shock loads, stresses and strains.

These performance factors are built into NAYLOR Spiralweld pipe through the distinctive spiral-lockseam structure. NAYLOR pipe is made in diameters from 4″ to 30″. Pipe ends of standard weight thickness are available.

Write for Bulletin No. 507 or call our distributors.

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LQ600®
PAYS ITS OWN WAY IN MAINTENANCE SAVINGS

One look at the precision-machined alloys in the LQ-600 Valve helps explain its maintenance-saving performance. Seats and discs are made of Brinalloy®, the exclusive Lunkenheimer alloy that actually outwears 500 Brinell Stainless Steel or Case-Hardened Stainless exceeding 1000 Brinell. Add Stemalloy®, the most durable stem material ever put into a valve, and you have the two big reasons why LQ-600's are setting new standards of performance everywhere they are installed.

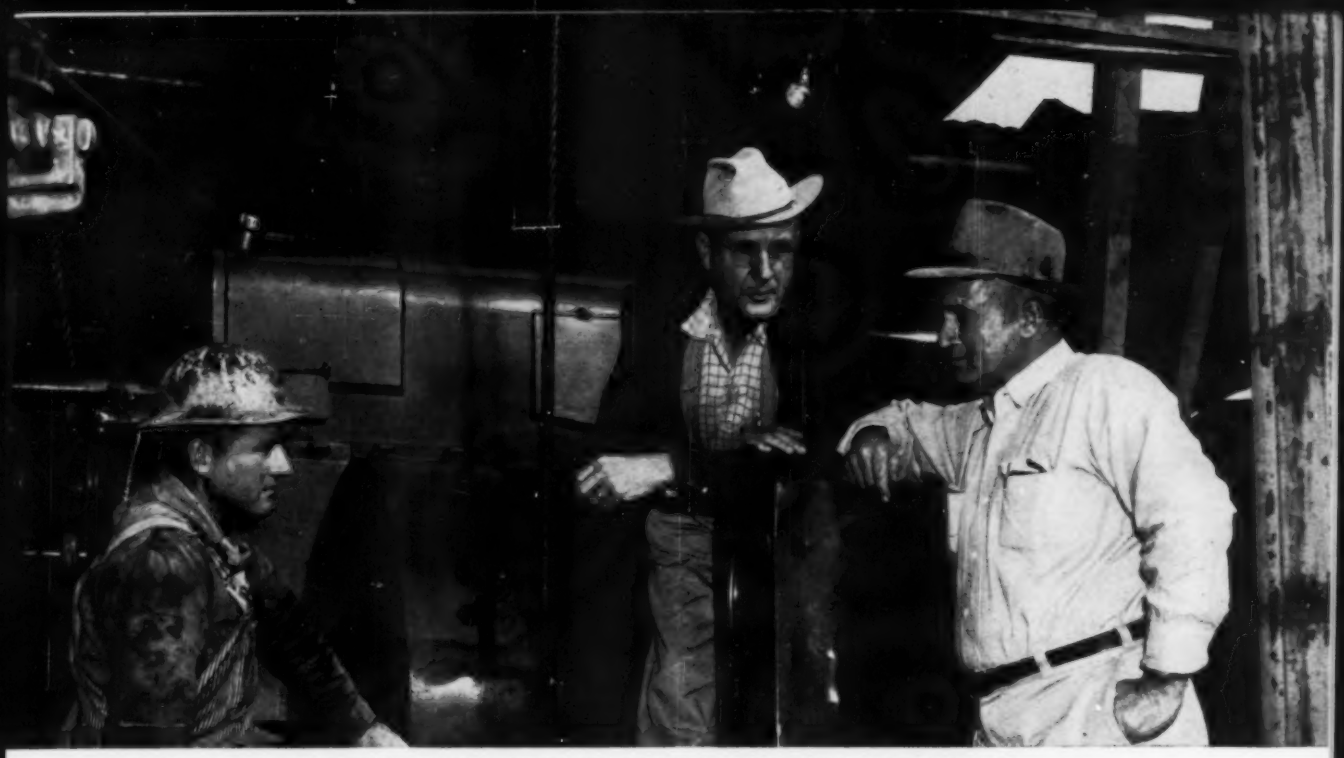
Compare this performance to any other valve in its class. Call your Lunkenheimer Distributor for a test installation . . . or write The Lunkenheimer Co., Cincinnati 14, Ohio.

LQ600-150
150 lb. S.P.
300 lb. W.O.G.

LQ600-200
200 lb. S.P.
400 lb. W.O.G. 550° F.

LUNKENHEIMER
QUALITY

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES



No signs of wear. Inspection of Tiger Brand Rope after drilling an 8600-foot well showed it to be in excellent condition with plenty of lubrication left.

"USS American Tiger Brand is as good a line as a man can find"

Says L. E. Fannin, Tool Pusher for Trio Drilling Co., Dallas, Texas

THE TRIO DRILLING CO. has four rigs—and they are all equipped with USS American Tiger Brand Wire Rope.

The tool pusher, Mr. L. E. Fannin, keeps accurate service records of each rope and checks the wear regularly. He says, "American Tiger Brand Wire Rope is hard to beat. It's as good a line as a man can find. That's why we use it on all our rigs."

This rig was strung with 1750 feet of 1⅛" 6 x 19 Tiger Brand Excellay Preformed Monitor with an Independent Wire Rope Core. Drilling Contractors all over the oil fields have found that this rope gives them the best service at least cost. It has a high tensile strength combined with an ability to resist heavy abrasive wear.

Why Tiger Brand gives you more for the money. With every Tiger Brand Wire Rope you get the results of years of basic research in steel making plus the application engineering of American Steel and Wire. What's more, the rope is produced under a rigid system of quality controls with plant facilities unsurpassed in the industry. These are the hidden elements that assure long service life and low wire rope costs. For more information, write to American Steel & Wire, Rockefeller Building, Cleveland 13, Ohio, or contact your local distributor.

USS is a registered trademark

American Steel & Wire
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Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Export Company, Distributors Abroad

11,028 independent businessmen like these serve you better with Standard's help

Wholesale distributor Bob Evans, Mesa, Arizona, uses a plant provided and maintained by Standard. We help Bob develop new business and back him with engineering assistance on his customers' lubrication problems.

Robert "Bob" A. Juner, San Francisco, operates his own service station. We supply him with business forms, maps, lube guides and major equipment. Bob makes good use of Standard's training programs to improve his service to you.

Standard's special Aviation Division helps airport dealers like Frank Kelsey, Salt Lake City, Utah, with wind direction indicators, flight guides and credit card service . . . all welcome conveniences to his customers.

Standard credit cards make it possible for independent marine dealers like Joe Faires, Port Angeles, Wash., to honor charge accounts. When fuel and lubrication problems arise, his customers can rely on help from Standard's engineers.

Liquefied Petroleum Gas dealers like Louis Marx, Atascadero, California, find our operations manual helpful in almost every phase of his business . . . especially when it comes to saving customers time and trouble on deliveries.

Keith L. Tweedie, Salem, Oregon, is a heating oil distributor. Our complete program shows him how to set up an accounting system, handle credit, cut operating expenses and give you the cleanest, most convenient service possible.

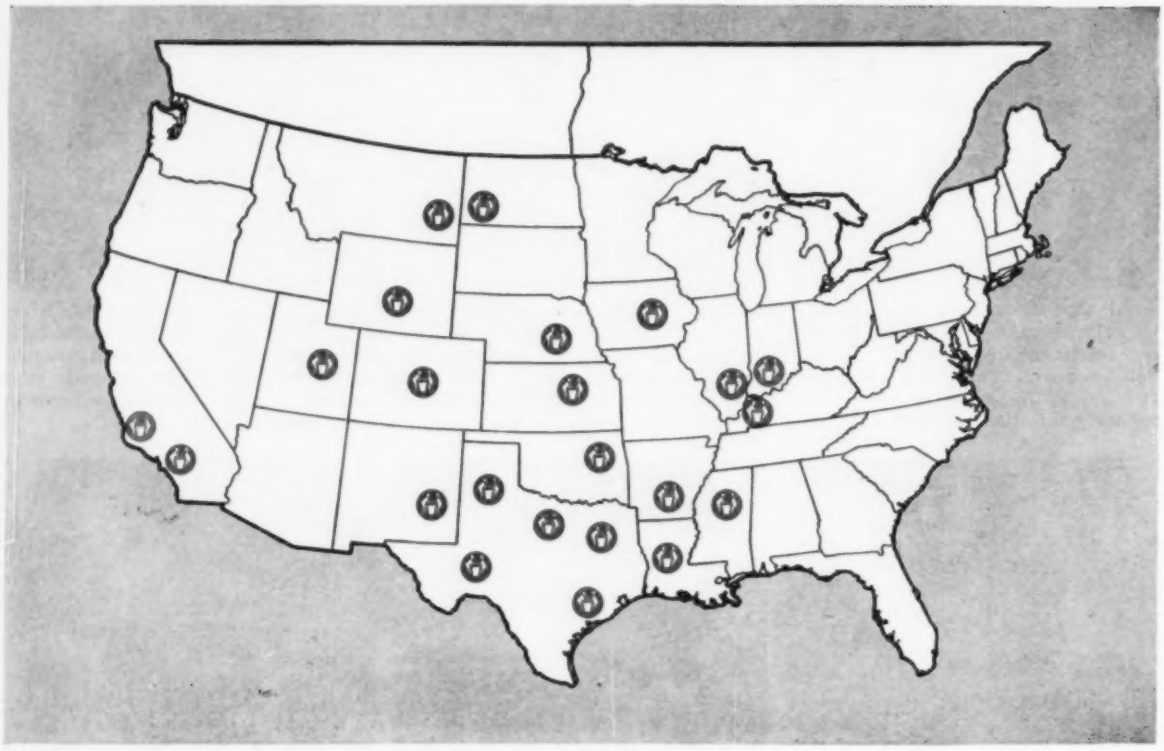
"Big Business" creates opportunities for "small business." With each doing the job for which it is best qualified, both are able to operate more efficiently . . . give you better service. Here's how it works with us.

Standard research and manufacturing skill assure quality products. In turn 11,028 distributors of Standard products, represented by these six Western independent businessmen, help bring you these products in the U. S., Alaska, Hawaii, B. C. and many other parts of the Western Hemisphere.

Because these independent businessmen perform an important service for us, we assist their efforts with technical help, suggested operations procedures, advertising and merchandising support. Thus by helping them to help themselves, we are *both* able to serve you better.

STANDARD OIL COMPANY OF CALIFORNIA *plans ahead to serve you better*

Financing from the **FIRST** *in Dallas goes where you go!*



Specialized experience, organization, and resources to help you with practically any kind of need for "working money".

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GIVE US AN OPPORTUNITY TO SAY · YES ·

put FIRST financing in your own oil future

Texas size tank

big even for Texas, this huge tank holds as much petroleum as 1,690 tank cars

it pays to plan with General American

You could discharge the loaded capacity of a train of tank cars over 12½ miles long into Phillips Chemical Company's huge storage tank at Cactus, Texas. With a diameter of 220 feet and a height of 48 feet, this new tank is one of the world's largest used for liquid storage. Liquid is pumped in at a rate of about 250 gallons a minute . . . and yet it takes nearly 37 days to fill this 323,000-barrel-capacity tank.

Phillips' new tank was engineered, fabricated and site-erected by General American. General American has skilled crews and modern erection equipment for both standard and custom-built storage structures.

If you are faced with the problem of storing liquids or gases, General American has the personnel, skill and experience to serve you. For information, call or write General American today.

PLATE & WELDING DIVISION

GENERAL AMERICAN TRANSPORTATION CORPORATION

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Importance of

Workable Project Planning

Engineering and Research and Development Departments can do a better job with "from-the-ground-up" planning . . . Here's a brief outline to follow in your organization to improve results

H. Warren Roos

SHORTAGE OF ENGINEERS and scientists is frequently only a surface manifestation of deeper problems. For every engineering and research and development executive who complains about problems of recruitment and turnover, there are a dozen who worry each day

. . . about the unprecedented pressure to get complex technical projects completed within allotted time and money limitations . . .

. . . about the serious problems of administration, control and communications in their departments, and. . .

. . . about the inevitable human relations situations that arise from all these pressures.

Problems of this kind have long been familiar in other sectors of business, but their impact upon groups of creative professional workers presents special complexities.

Better Planning

In some research and engineering departments there is serious need for better planning on fundamentals. Objectives must of course be carefully defined, and subjected to constant scrutiny. The amount of money to be spent and the size of the program must be well thought out and periodically reviewed. Good liaison must be maintained with other departments of the business. There must be proper balance between long-term and short-term work.

Every business executive knows the importance of these and other fundamentals. Too often, however, his planning does not go sufficiently beyond these basic points.

In every engineering and research and development department there is a function which, for want of a better term, we call "work-planning." This activity embraces

. . . thinking through the detailed steps which must be taken to carry out a given project . . .

. . . making appropriate arrangements to accomplish each step in proper sequence, and . . .

. . . comparing, reconciling, and coordinating the cost and timing of each of these steps with overall company, calendar, financial and manpower objectives.

As projects are planned and estimated, their progress checked, then replanned and re-estimated, this work-planning becomes almost a continuous cycle.

Remember the engineer or scientist is the productive worker, his work is creative, and he must, to a large degree, set his own pace. He feels akin to management, and likes to participate in its plans. He is keenly conscious of his professional development, and prefers to work in the upper range of his skills. Failure to consider these factors is not only a deterrent to professional productivity, but is responsible for much turnover and unsatisfactory morale.

In planning and scheduling engineering, development and design work, one basic approach, one philosophy, and many psychological factors have almost universal application. Mechanically and administratively, however, it is important that each system be developed in an individualized manner to meet the requirements of the department and company where it is to be used.

When the right method of work-planning is installed, the benefits can be very substantial. Completion of engineering and research and development projects can confidently be expected on time and under budget, to fit in with the plans of the company as a whole; manpower needs and costs will be reduced; and better morale will result.

From-the-Ground-Up Planning

The kind of planning needed might well be called "from-the-ground-up" planning. There are four benefits to be derived from "from-the-ground-up planning." Some are as important, if not more so, than on-time, under-budget performance.

1. Better utilization of the engineers' time. This can accomplish much to alleviate technical manpower shortage.

Engineers and scientists should be free to devote most of their time to those portions of their projects which require their specific talents. Less demanding work is more easily delegated to subprofessional trainees, and to clerical and technical assistants, and the proportion of the latter to total staff invariably rises, reducing payroll costs.

2. Improved morale of the engineers and scientists. This is reflected not only in lower turnover, but also in better productivity and job satisfaction.

Engineers and scientists usually have no objection to working under a schedule, provided they themselves have had a part in making it, and have helped set their own goals. This participation helps give them the desired sense of identity with management's objectives and means of attaining these objectives.

Mr. Roos is vice president, Wallace Clark and Company, management consultants, New York.

3. Management can better gage work-load requirements. Management gets precise, continuing knowledge of its work-loads with this type planning and it can better evaluate the engineering and scientific staff.

One company believed it had a backlog of 18 months' engineering work, and was actively recruiting additional engineers. While developing a program of planning for this department, it became apparent that the administrator was staffing up for certain projects still in the "dream stage."

When only those projects actually ready for engineering were considered, the backlog proved to be only three months' work.

4. Ease of pooling purchases. Project managers may requisition through purchasing on an uncoordinated basis, and some purchasing is practically on a retail basis.

Planning enables material requirements to be more easily forecast, combined and coordinated. The number of uneconomic lots is reduced and more quantity discounts are secured.

Organization

A simple by-product of "from-the-ground-up planning" is that the administrator is provided with day-to-day knowledge of the status of each project in terms of progress, delays and workloads. With better management tools, his problems of administration are simplified. This simplification often makes it desirable to effect minor changes in the organization structure.

Fundamentally, there are only three basic types of organization structure used in E and R&D departments. These differ largely in the degree and manner of centralizing.

1. One type is distinguished by having, in the engineering department, a fully centralized design division. With this structure, proper advance planning of work is extremely important, or project managers may receive unsatisfactory service and costs will rise.

Unless there is good planning to offset this handicap, the advantages of a stable and uniform work-load in the design division may be outweighed, making it inadvisable to use this type structure.

2. Under another type structure, each project manager has line authority over his own design staff, and sometimes over some of his own service personnel as well. This structure calls for some supervisory ability on the part of the project managers, who may not have been selected for this trait.

Unless the skills, patterns and the nature of the department's projects are appropriate, this type structure may require frequent moving of men from one project to another, creating problems of layout, furniture, etc.

3. A third type structure combines advantages of both these types and can be used with conspicuous success.

There are few situations, of course, where one or another of these types of organization structures can be used without modification. A department must always consider complicating problems such as whether a certain activity is predominantly line or staff, how to correlate the work done at distant plants or laboratories with that done at headquarters, etc.

As a result, no one type of organizational structure suits all companies, nor even all the departments in the same company. There are, however, factors in each situation, usually centering around the types of skills and projects which indicate the right structure to meet the need. The conscientious engineering or research and development administrator will want to consider whether his department is using the correct organizational structure. ★ ★

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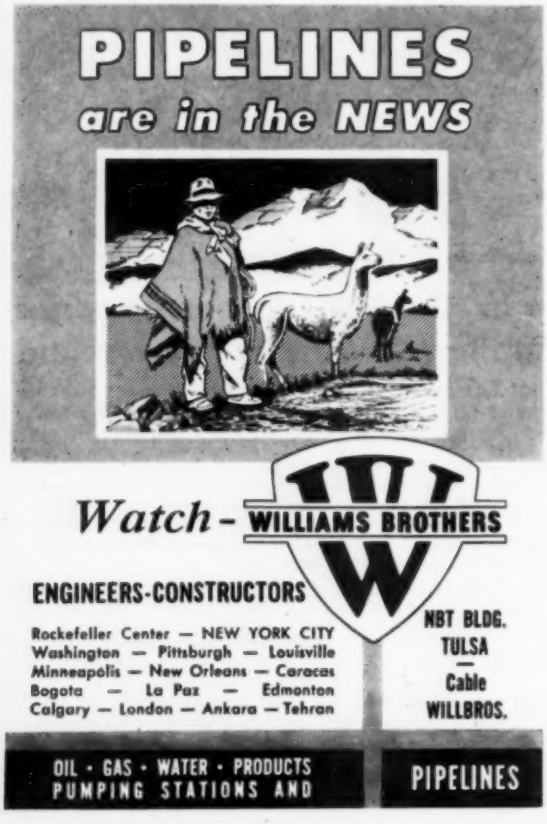

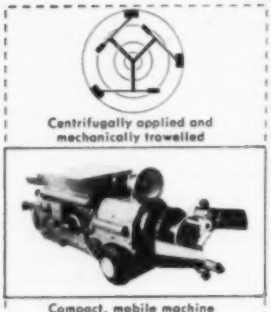

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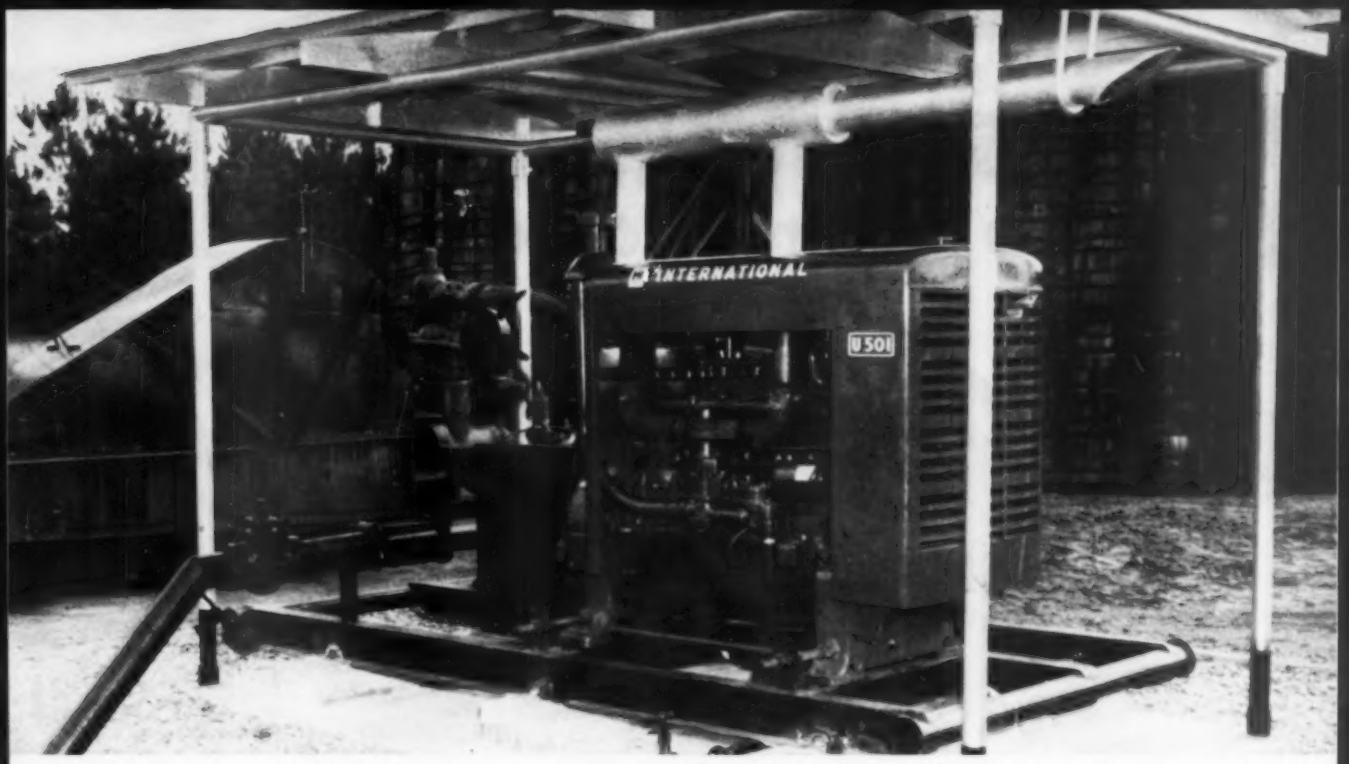

This natural gas U-501 6-cyl. power unit with Gould pump injects 85,000 gallons of waste salt water into six dry wells daily for the Ohio Oil Co., Haynesville, La. Process aids recovery of hard-to-get oil.

International repowering proves profitable on drill rig, pump

Producer, drilling contractor get more for their power dollars by changeover to heavy-duty, dependable International engines

Twin International U-450 power units drive the drill rig and mud pump for J. P. Crain on this operation near Stevens, Ark. About 750 feet of 7⅞" pipe is put into the ground every 24 hours.

A large producer and a drilling contractor recently made similar discoveries about practical advantages of repowering equipment with dependable, heavy-duty International engines.

At Haynesville, La., the Ohio Oil Company could inject salt water into only one pumped out well with an old engine. Now, with a new International U-501 6-cyl. engine on a Gould two-stage centrifugal pump, 85,000 barrels of salt water is injected daily into six wells, up to three miles from the gathering pit.

In the Pace City field, Stevens, Ark., drilling contractor J. P. Crain, Moorings Port, La., found he could increase production with no increase in cost by repowering with International. He bought two new International U-450 engines for the same price he originally paid for the replaced single engine on his Wilson Sr. rig and 5" x 10" Gaso mud pump. But now increased drilling power lets him finish off a 2,900-foot well in just four days.

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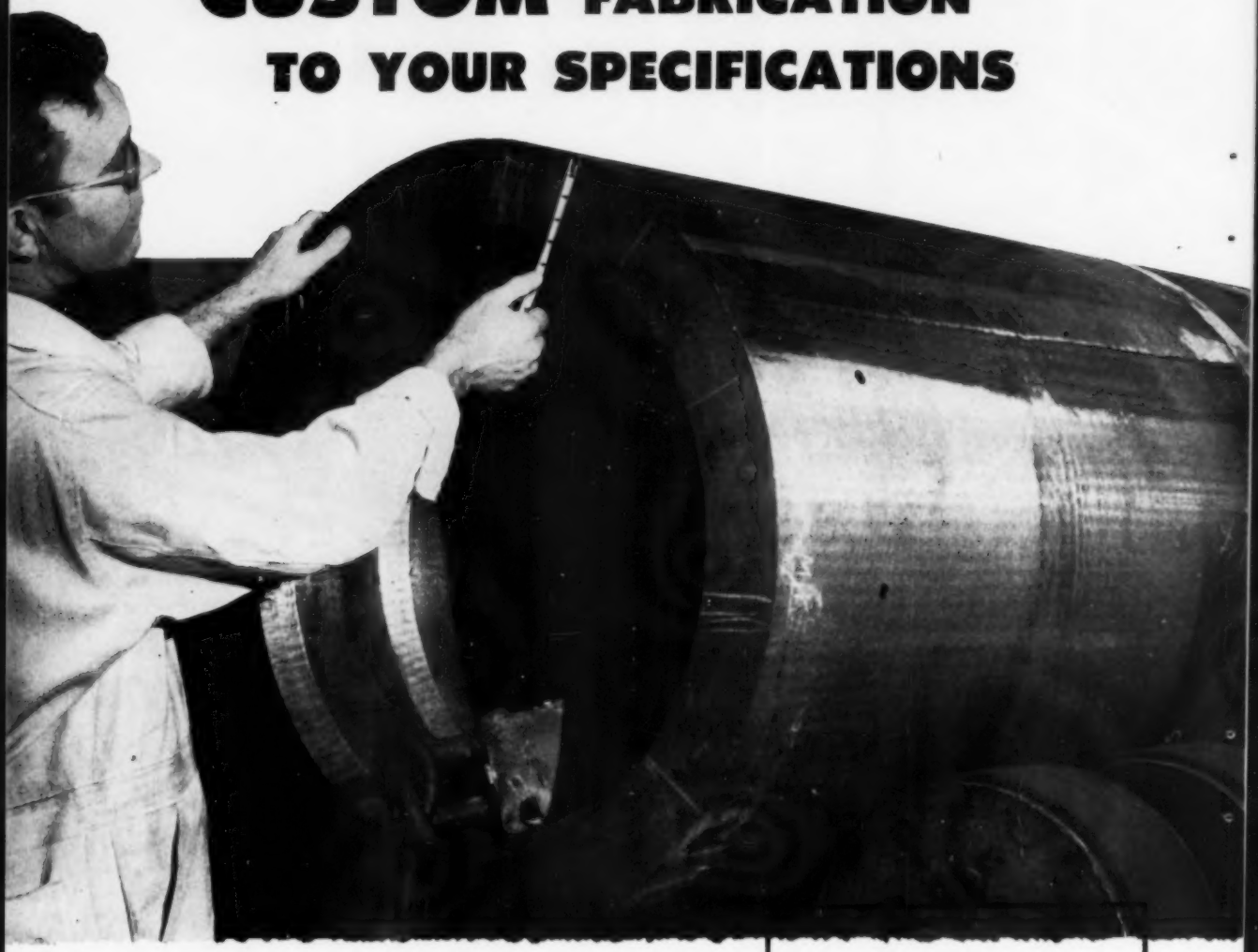

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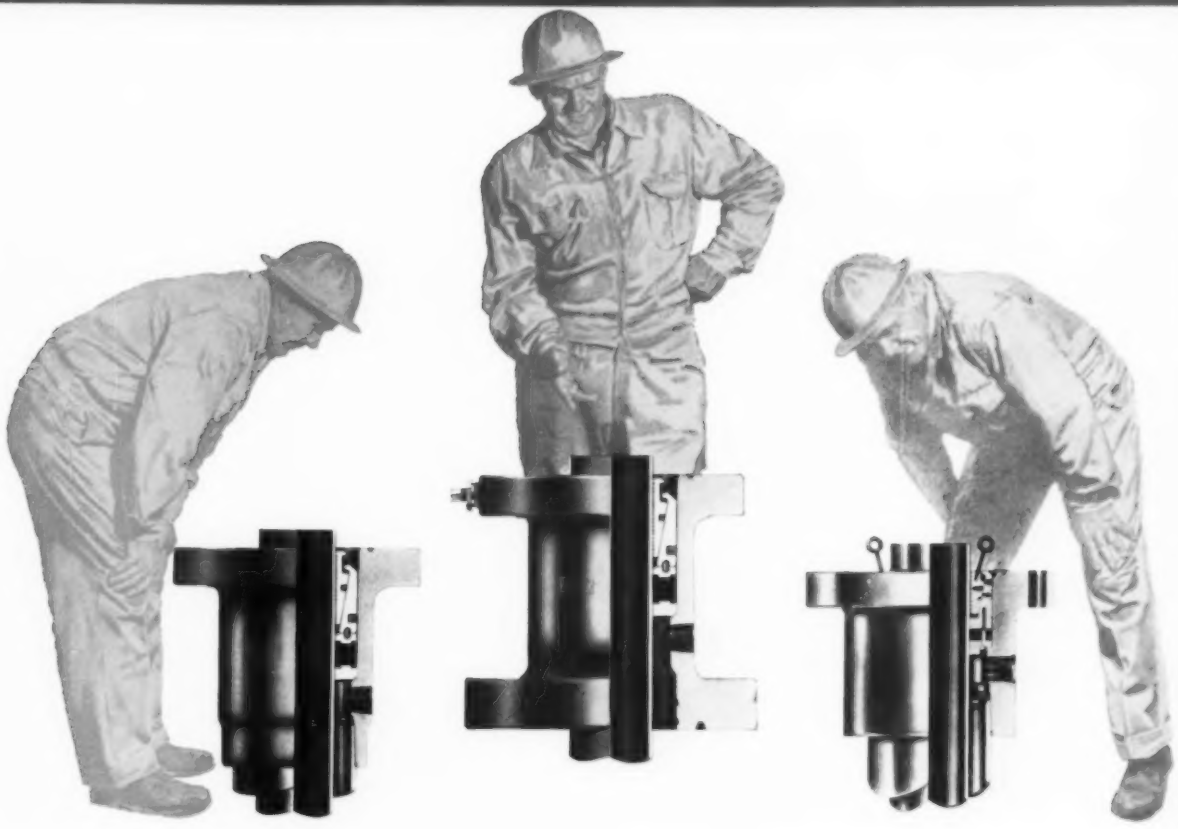

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Of Things To Come . . . In Oil

SEPARATE PLEAS IN COMBINED TIDELANDS CASE will be made by each of the five Gulf Coast states facing suit over control of submerged lands. States' lawyers in the case, to be heard by Supreme Court October 13, have agreed to permit each to have one hour to argue individual claims to offshore lands between 3 to 10½ mile lines. States combining legal efforts are Louisiana, Mississippi, Alabama, Florida, and Texas. U. S. advised states it will not hear separate cases by each state.

D&A: NATIONAL PETROLEUM COUNCIL. Temporarily suspended operations of NPC may become permanent. Walter S. Hallanan (Plymouth Oil president), who heads 102 oilmen in its government advisory capacity, informed members no future meetings will be called — until its antitrust dispute with Justice and Interior Departments is solved. Under government rulings, Hallanan will be replaced by government chairman and advisory decisions — made by the present "civilian" group — would come through government channels.

IMPROVED METHODS OF LOCATING STRATAGRAPHIC TRAPS are being claimed by Atlantic Refining Company, who is "aggressively at work" on such a project. While difficult to locate with existing techniques, strat traps probably represent largest accumulations of untapped oil in U. S. Atlantic says it is too early to forecast results of their research in this direction.

INDUSTRY ENTERING NEW PHASE OF PETROLEUM FINDING, judging by statistics on proved reserves. End of 1957 showed U.S. total recoverable reserves at 30.3 billion bbl, first drop in over a score of years. 1956 reserves tabulated at 30.4 billion bbl. Scientists say this leveling out of oil finding reflects "dullness" of our oil-finding tools. And they say, U. S. oil industry is embarking upon a new phase of oil recovery to keep pace with production.

NEW INVERTED EMULSION CEMENT HOLDS PROMISE in minimizing wetting the formation when cementing casing opposite producing interval. Normal Portland cement slurries are known to wet the sand face which blocks oil production in some critical wells. Developed by Magnolia Research, new cement keeps minimum water as internal phase until accelerator breaks emulsion due to temperature reaction.

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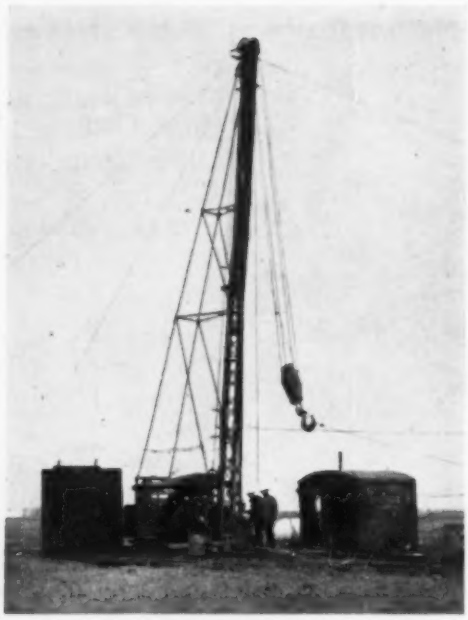
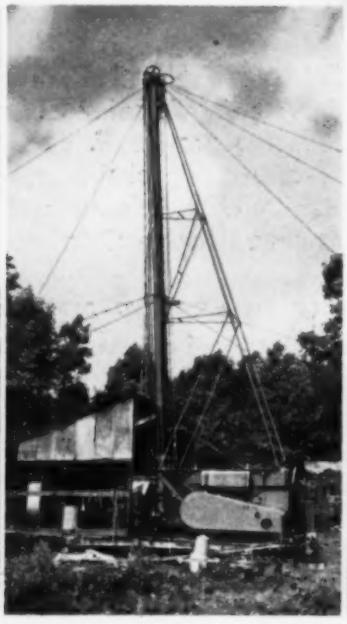


A 60-L owned by Gaines Drilling Co., El Dorado, Kans., cleans out a 1900-ft. well (about 40 years old) in a Cities Service water flood project west of El Dorado. Says Driller Mack Gaffney: "I like 'em. Bucyrus-Eries have a good snappy spudding motion." Driller Harley Nicholas adds: "I've worked a lot of rigs in different formations all over the country . . . and I like Bucyrus-Eries for their steady, trouble-free performance."

Owners of five Bucyrus-Erie spudders, Greer Bros., Whitesville, Ky. consider the 60-L as "the only rig for drilling in Kentucky". This 60-L is cleaning out a well in the Apex Field near Greenville. High line speeds assure rapid progress on hole after hole. Mobile trailer mounting, telescoping derrick, and folding tubular braces save time of moves.



A Halliburton crew runs a Hydrofrac to increase the gas flow from a 3,113-ft. well in west central Pennsylvania. Joining in the operation, Ed E. Hess, Clarion, takes advantage of the speed, strength, and capacity of his 36-L to set casing, handle tubing, and run treatment packers.

"We had all kinds of equipment," says E. M. Hale, Ada, Okla., "but we've standardized on 28-Ls for quick moving. We worked over 23 wells in six months on a water flood project with never a breakdown for either rig." Hale (extreme right) watches his men swab fracture oil and fresh crude through perforations on a well in the Wetley Field.

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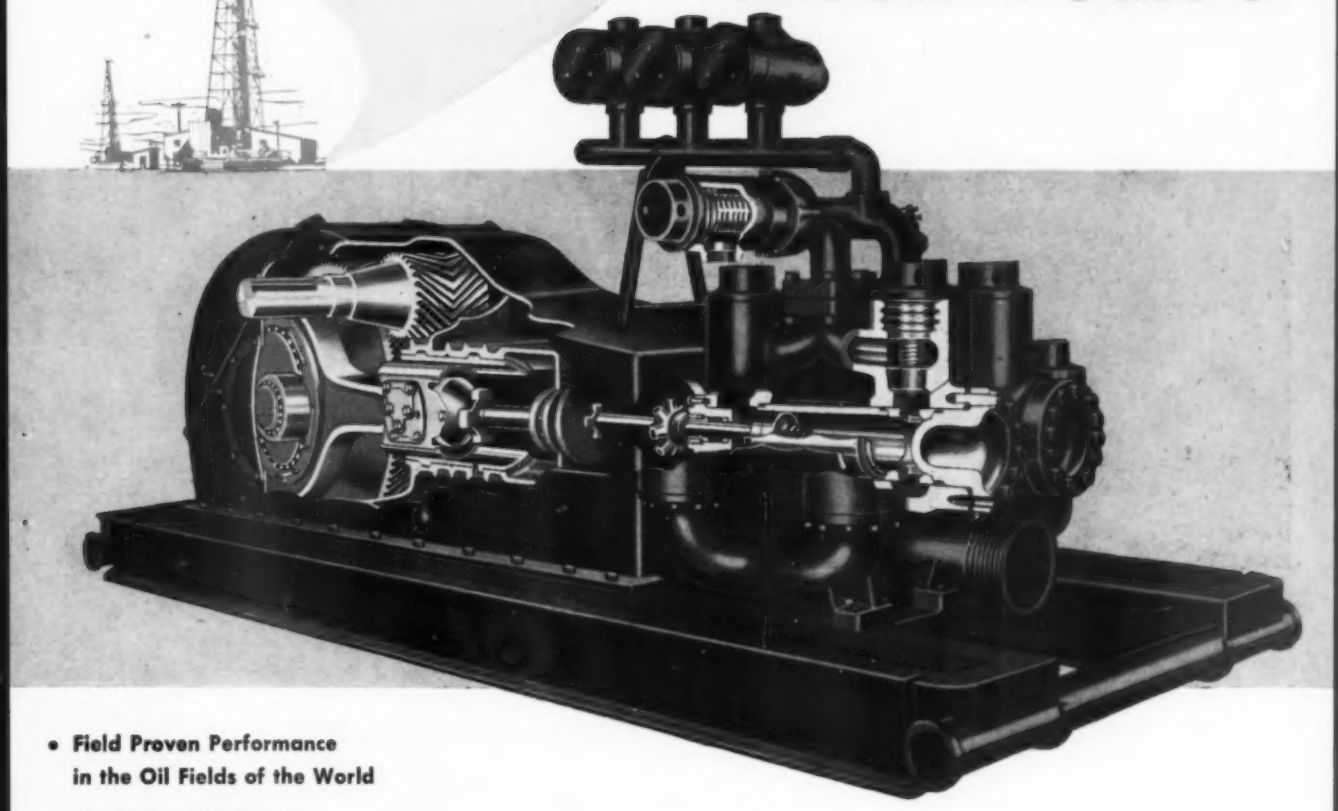

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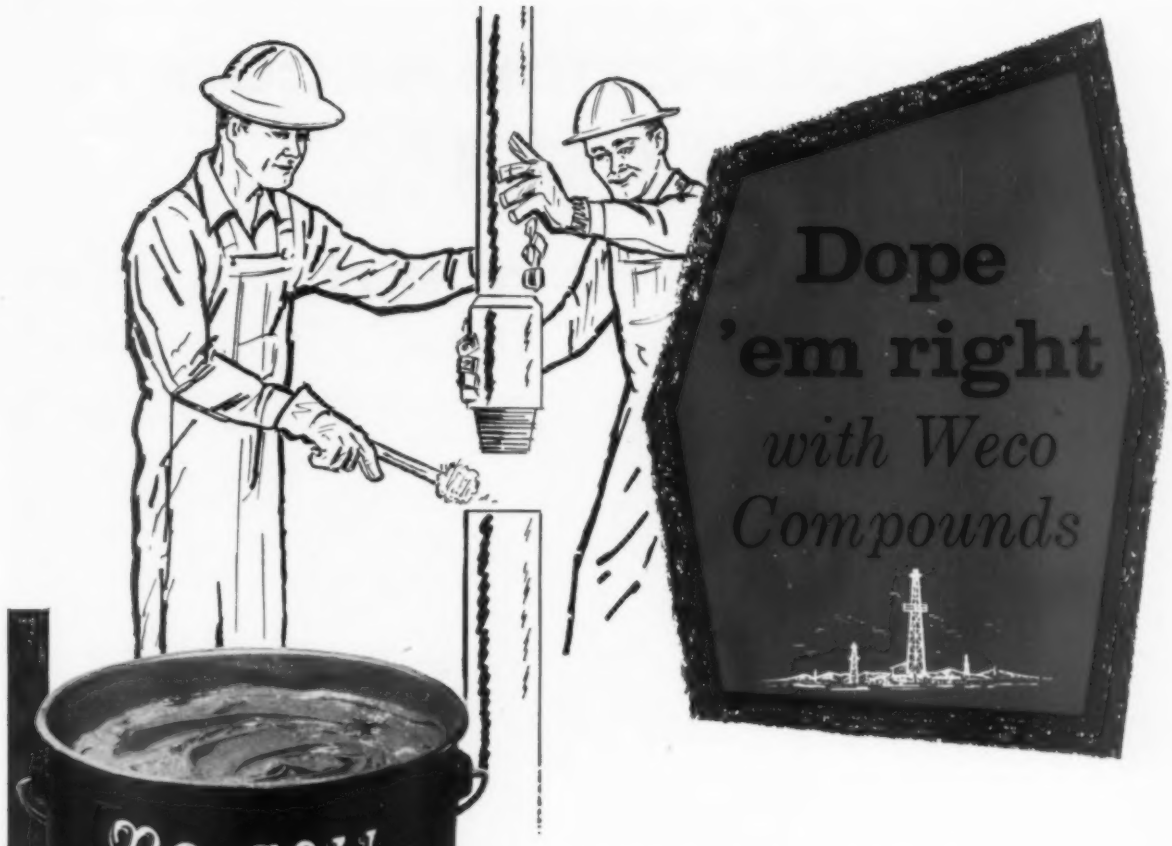

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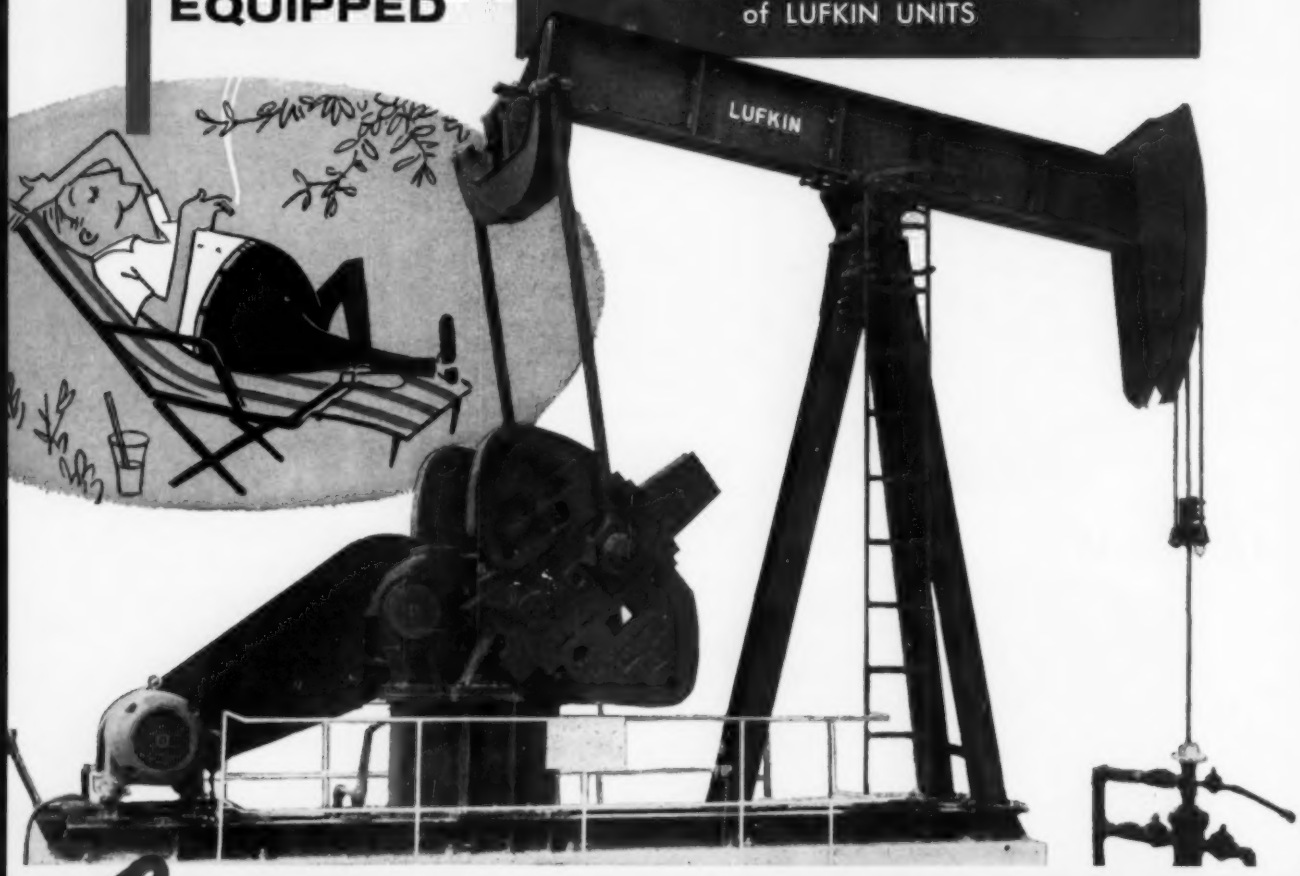

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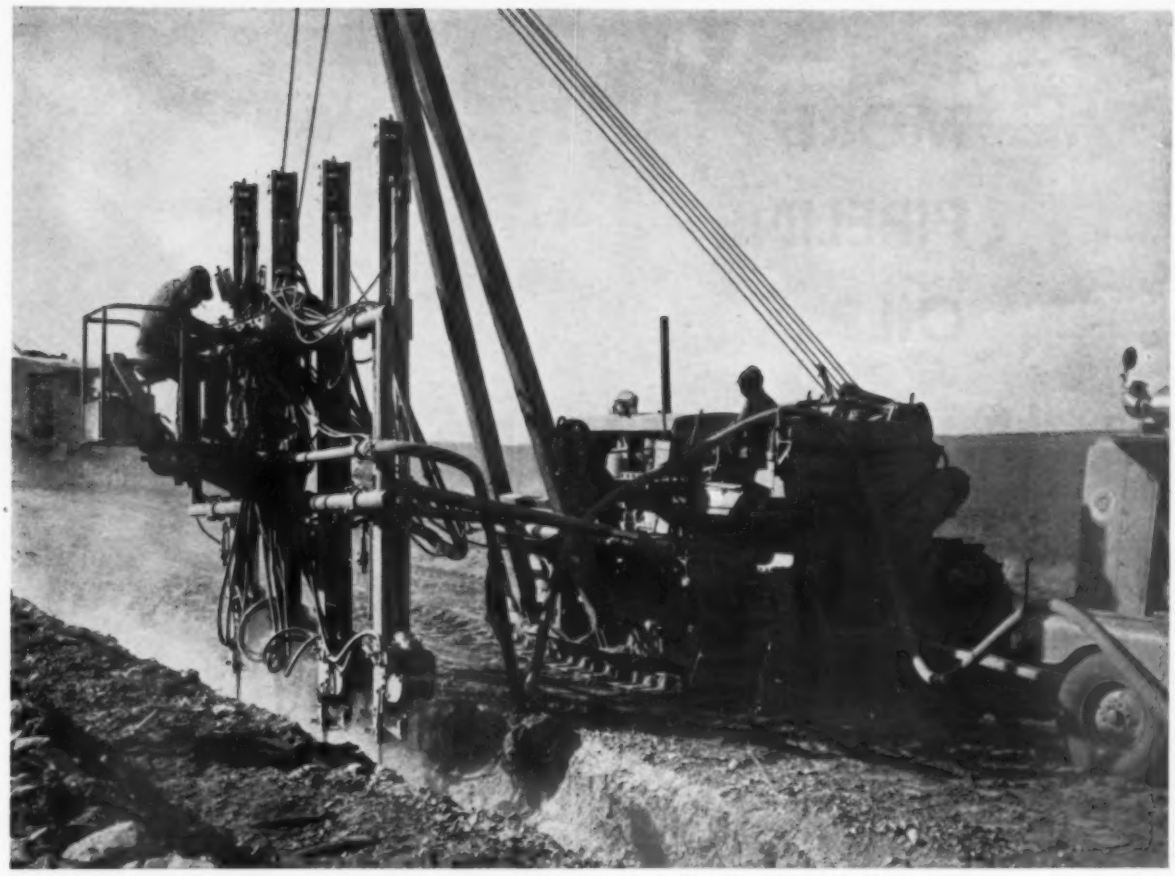

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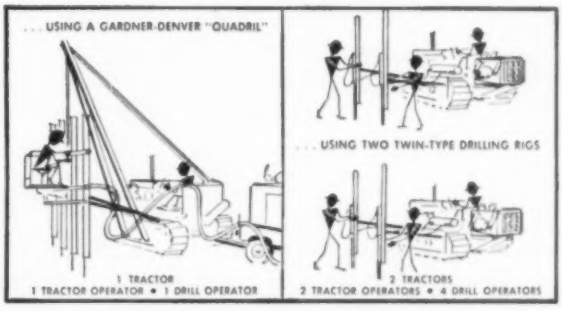
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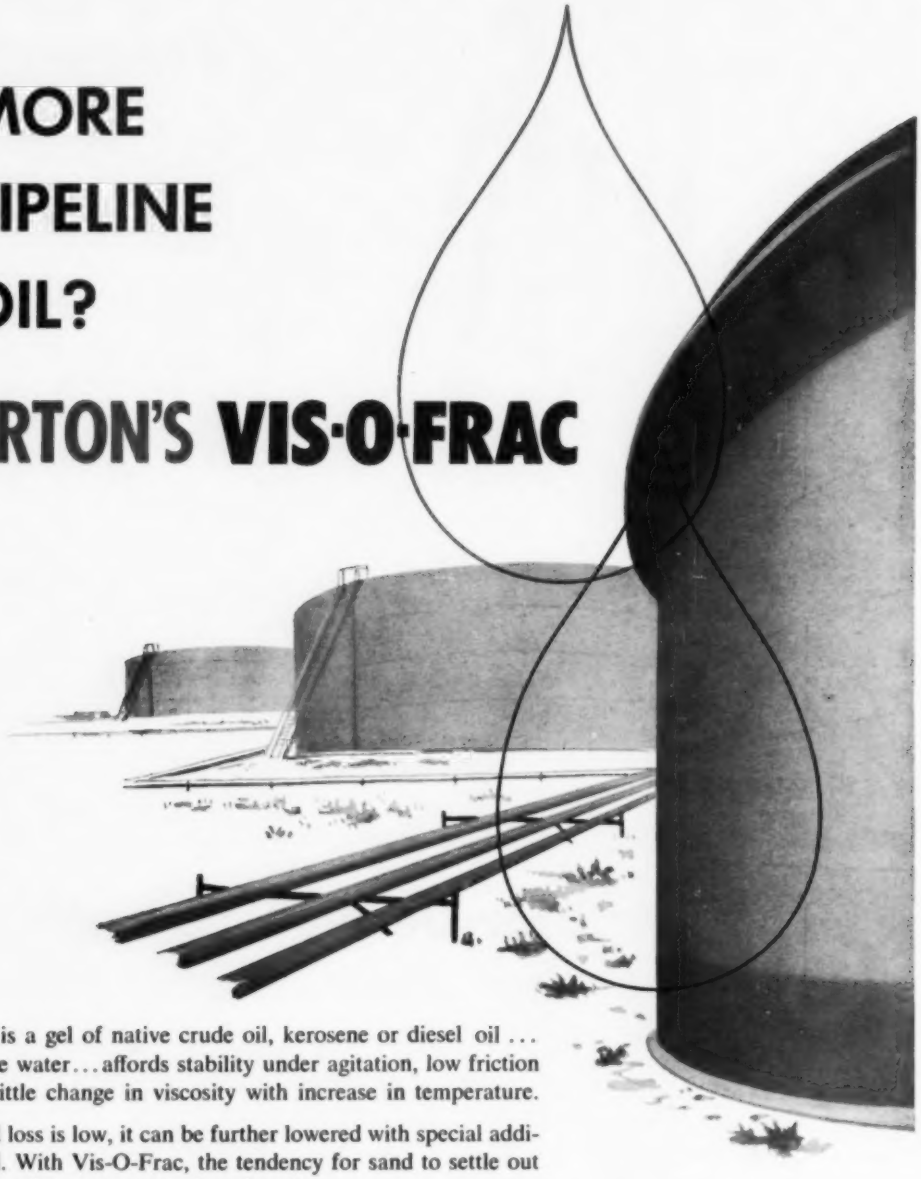
MORE PIPELINE OIL?

HALLIBURTON'S VIS-O-FRAC



Vis-O-Frac is a gel of native crude oil, kerosene or diesel oil ... contains no free water... affords stability under agitation, low friction pressure, and little change in viscosity with increase in temperature.

Though fluid loss is low, it can be further lowered with special additives, if desired. With Vis-O-Frac, the tendency for sand to settle out during slow pumping or stoppage is reduced.

Shut-in time after treatment is reduced through rapid thinning and mixing with formation oil..."Pipeline" oil may be produced and sold without treatment.

For more information about Halliburton's Vis-O-Frac and other fracturing treatments... to determine which is best for your well... call Halliburton Fracturing Services.

Ask for your free copy of Halliburton's NEW bulletin, "Elements of Hydraulic Fracturing."

HALLIBURTON FRACTURING SERVICES

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Duncan, Oklahoma

FIRST AND FOREMOST
IN ALL FRACTURING
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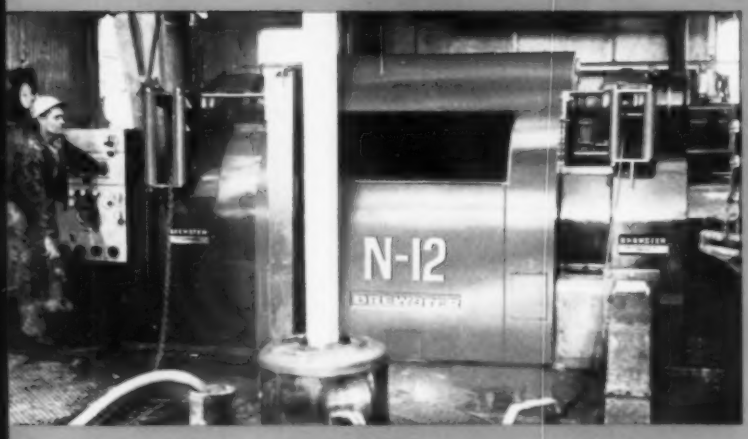


PENROD RIG 42

POWER-PACKED NEW DESIGN BY BREWSTER

Boasting over 100 horsepower for every foot of beam this new Penrod rig is a new concept in barge design. Gone are the frills and showboat accommodations. This new barge will drill to 20,000 feet and packs the equipment to do it in just 30 feet of width and 186 feet of length. Drawing only six feet under way she will go up to most locations without dredging or widening.

Let Brewster quote you on a drawworks designed to your special drilling requirements.

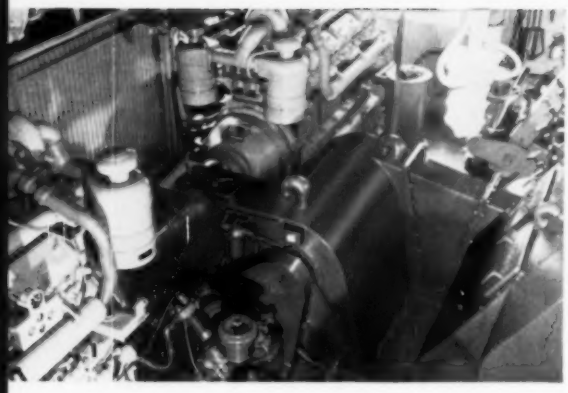
Turn the page to see the other power features of Rig 42

BREWSTER

J. P. Johnson, Superintendent for Penrod Drilling Company who originated the design for Rig 42, says, "This rig was built for maximum use of power, a minimum of barge, maximum rig. Its performance record has been excellent."

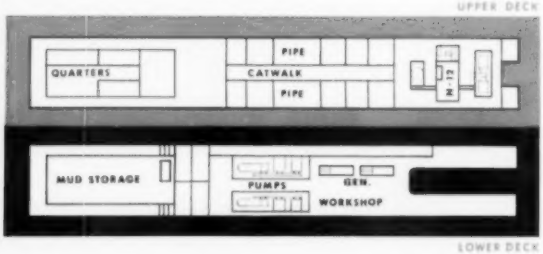
Starting top side Rig 42 has a Brewster N-12 Reserve Powered Drawworks. Two "Cat" Turbo charged D-397's furnish the power. A unique offset compound on the N-12 places the engines opposite each other. This shortens the overall drawworks and compound length to just 18' 6".

Capable of 20,000 foot drilling the Brewster N-12 has eight forward and two reverse speeds. Four speeds are available at the rotary table. A field proved design, the N-12 turned in a First Hole record of 11,200 feet in eleven days' time including spudding in and crooked hole trouble.



POWER-PACKED COMPOUND was designed by Brewster to fit Rig 42's new concept in barge design. Developing over 1200 horsepower the Turbo charged "Cats" are linked to the drawworks by a minimum of compound and chain, requiring only 10' 8" in depth behind the drawworks. Note how auxiliaries such as the air compressor and oil pumps have been placed to use a minimum of space yet they are completely accessible.

TWO PUMPS WIDE the hull wastes no space yet allows plenty of work room. Each pump is powered by two Turbo Charged D-397 "Cats". The full mud system can be seen in the foreground. Dry mud storage is provided in after section of first deck.



A 500-TON BREWSTER BLOCK and 8SX swivel handle the drilling string. The Rotary Table is a Brewster 27½". This "Matched Equipment" for the Reserve Powered Brewster N-12 gives Rig 42 a balanced team to speed drilling.

THE BREWSTER COMPANY, INC.

Shreveport, Louisiana

SUPPLY HOUSES

Howard Supply Company • Apex Equipment Company • Bovaird Supply Company • Industrial Supply Company • Murray Brooks, Inc. • United Supply and Manufacturing Company • Export Sales: The Brewster Company • (HOMCO) Houston Oil Field Material Company, New York, N. Y., Houston, Texas; Mexico City, D. F.

Anti-lock prevents relative rotation between anchor cage and tubing while running

Re-latch threads prevent upper slips from setting until ready.

Long, flexible drag springs allow easy recovery in case of washover.

Special seal protects against fouling from sand or scale.

Internal shoulder creates a differential piston inside rubber to cause a tighter seal.

Full setting force is transmitted to packing element through lower head. No scrubbing action between lower slips and casing wall during setting stroke.

Guiberson permanent completion

TYPE A DRILLABLE PACKER

runs and sets easily, quickly

- ***Built-in safety against premature setting***
- ***Set and produce in ½ tubing trip***
- ***Unequalled rubber seal***

Guiberson Type A Drillable Packer gives you a versatile packer for many uses..single or multiple zone production, acidizing, pressuring operations, water-flooding, testing, corrosion control and many others.

New safety factors against premature setting are provided since the transmitting of drag from tight casing or impact from junk is direct to the tubing string.

The Type A can be set and placed in production with only ½ tubing trip. Spacing problems are easier, especially when run in combination with a multiple zone packer. From rig floor to completion, the Type A runs and sets faster than any other permanent packer.

Guiberson superior quality rubber and special lead-alloy thimbles compress fully for a leak-proof seal. Setting is quick, easy and uncomplicated..may be set by wire line. Available in 5" through 7⅝" sizes for 2" or 2½" tubing with a full line of stingers and accessories. Ask your Guiberson representative for a recommended installation or write for full details.

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DALLAS, TEXAS
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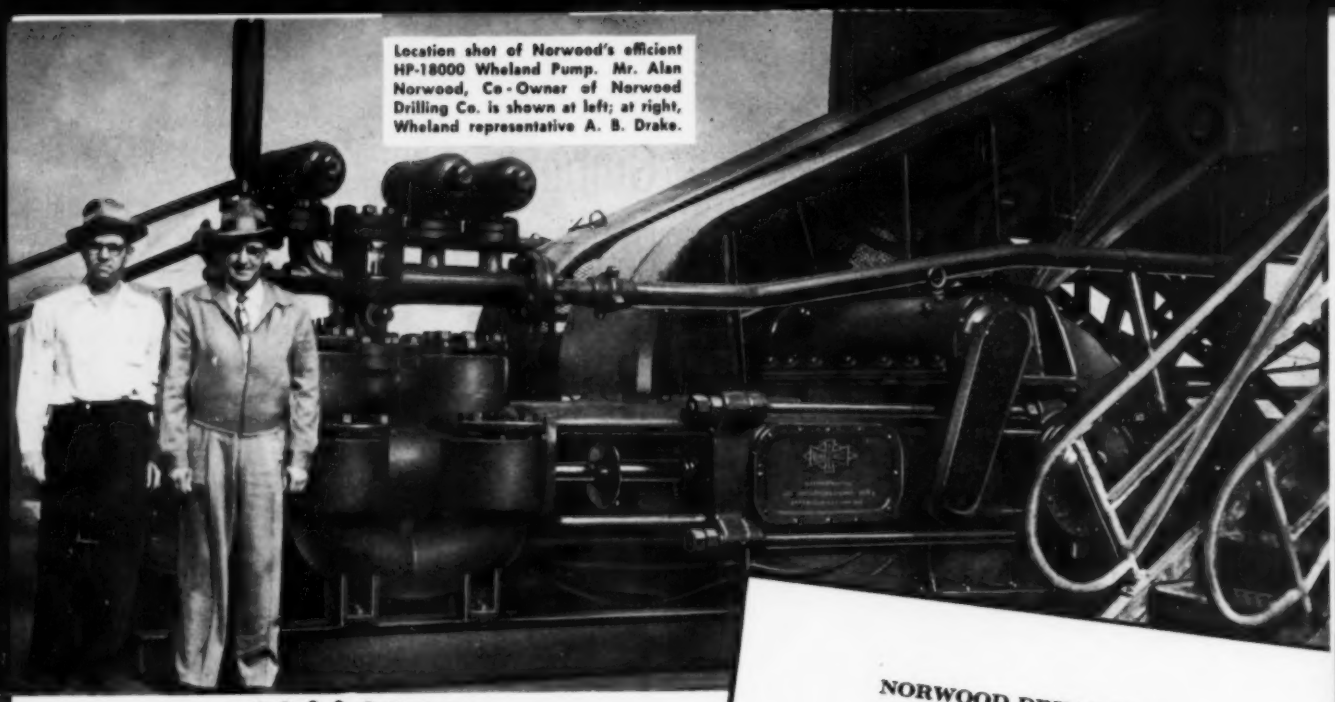
Everywhere



Location shot of Norwood's efficient HP-18000 Wheland Pump. Mr. Alan Norwood, Co-Owner of Norwood Drilling Co. is shown at left; at right, Wheland representative A. B. Drake.

PERFORMANCE!

". . . has fully met our expectations on performance . . ."

"have had no expense on this pump"

WHELAND HP-18000

DUPLEX SLUSH PUMP

7¾" x 18", 750 HP Nominal Input at 60 RPM.
Discharge Pressure with 7¾" liner, 1322 PSI;
Discharge Pressure with 5½" liner, 2700 PSI.

BULLETIN ON REQUEST

NORWOOD DRILLING CO.
WICHITA NATIONAL BUILDING
WICHITA FALLS, TEXAS

January 21, 1958

Mr. Gordon P. Street
The Wheland Company
Signal Mountain Road
Chattanooga, Tennessee

Dear Mr. Street:

We operate six rigs in West Texas and New Mexico area; depths range from 5,000 feet to 14,000 feet.

The Wheland HP-18000 pump we bought more than a year ago has been in the West Texas area working on wells between 10,500 feet and 13,500 feet. It has fully met our expectations on performance and so far we have had no expense on this pump.

Yours very truly,

NORWOOD DRILLING COMPANY

By: Alan Norwood
Alan Norwood

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.

DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

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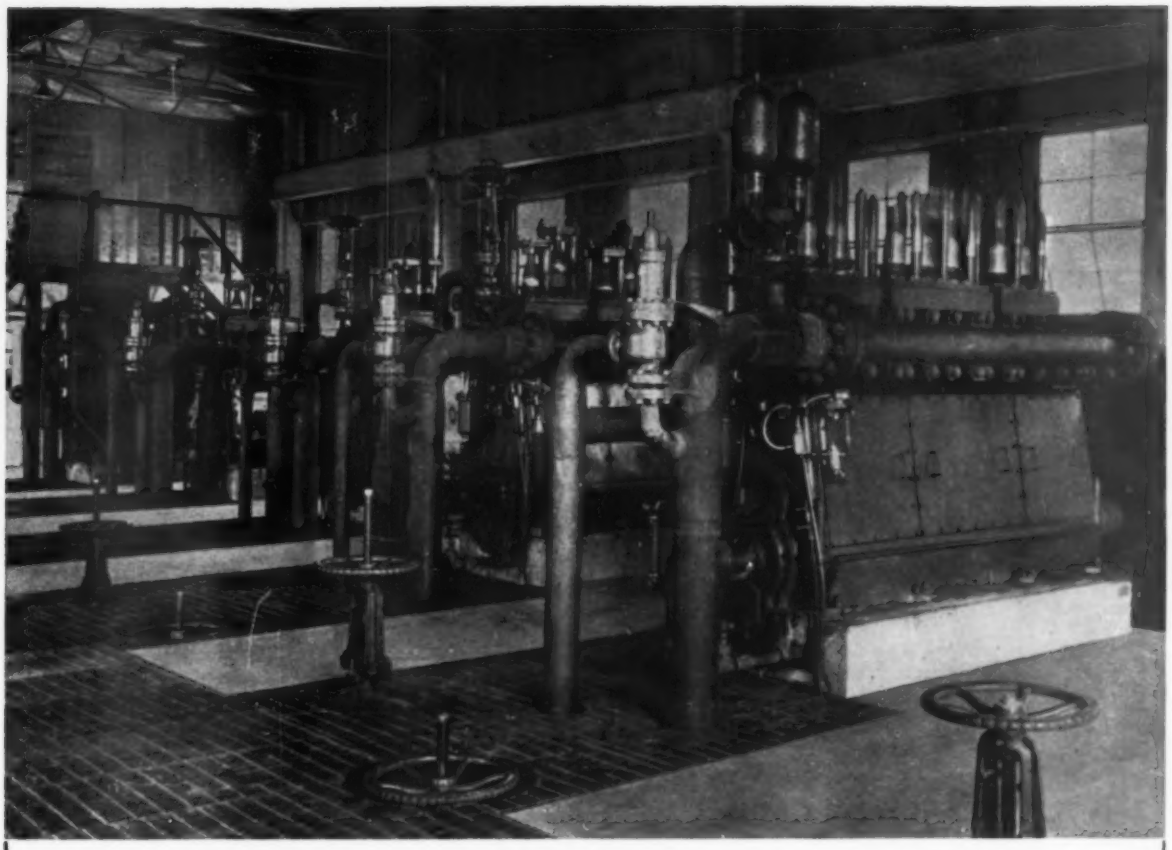
EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.



FIELD REPORT

FLOOD: Salem Unit

PUMPS: 10 Aldrich Pumps

2 Variable Stroke, 2 Triplex, 2 Quintuplex, 4 Septuplex

FLOODING STARTED: April 1953

EXPERIENCE TO DATE:

Pumps operating currently under 800 lb pressure, delivering 171,000 bbl a day. Handle mixture of fresh water and oil field brine. Routine maintenance every 4000 hours. Customer reports pump operation and Aldrich field service "satisfactory."

Field parts stock available in Carmi, Ill.; Charleston, W. Va.; Houston; Los Angeles; Odessa and Tulsa. For further information, write the Aldrich Pump Company, 26 Pine Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

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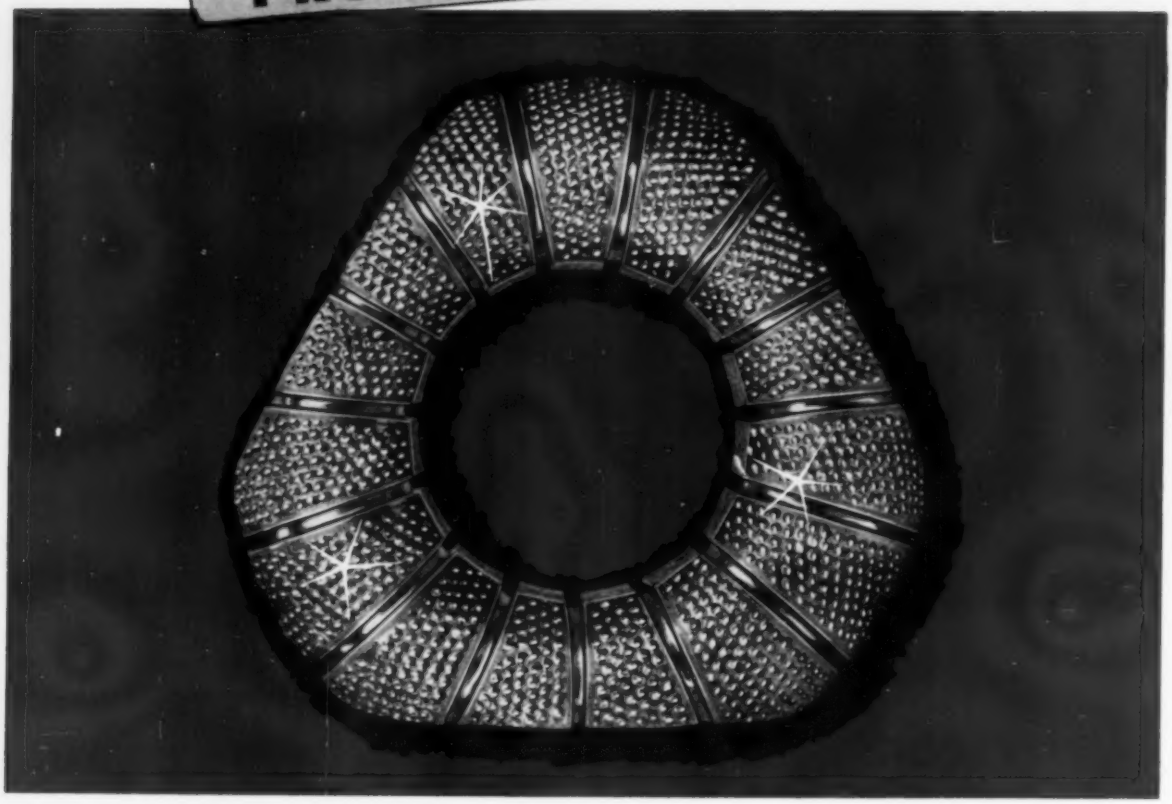

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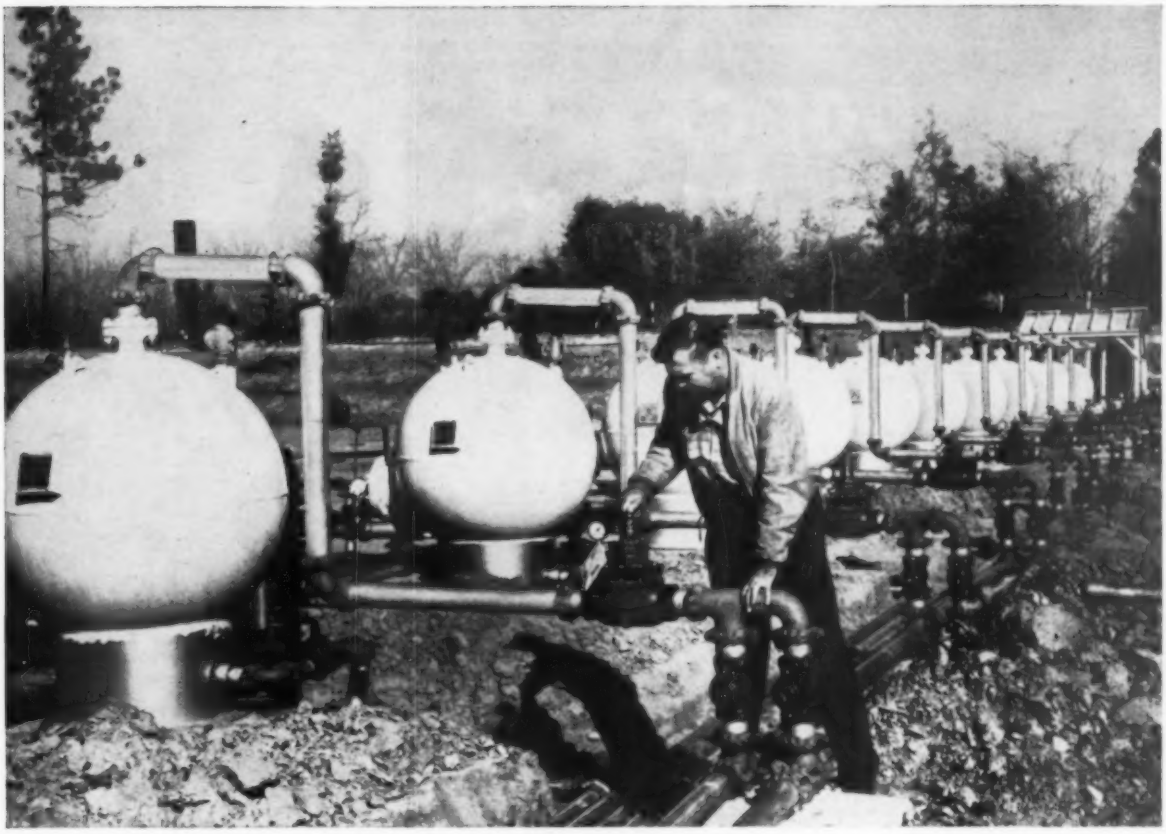

350,000 ft of this lightweight, corrosion-resistant piping of Alcoa Aluminum form flow lines, gathering lines and tank battery lines. The pipe's light weight keeps laying costs low by making possible larger truck loads, smaller crews and faster laying. Excellent corrosion resistance gives the aluminum pipe long service life with no maintenance.

Light, strong, corrosion-resistant . . .

Alcoa Aluminum Pipe links well heads with tank batteries for major oil producer

A major oil producer now joins well heads with tank batteries in a new field through some 350,000 ft of light, strong, corrosion-resistant ALCOA® Aluminum Pipe. Why? The reasons are simple.

The company has found that the light weight and handling ease of aluminum pipe mean important savings in pipe laying costs. Such savings have run as high as 77%. Still other economies are possible in service because of the excellent corrosion resistance of aluminum pipe and its good mechanical properties. The important net result is this: piping that is very frequently the most economical in terms of actual cost per foot in service.

You, too, will find that portable piping of ALCOA Aluminum is frequently the best and least costly answer to your oil country piping needs. It is available in quantity through most major oil field supply houses. Quick couplers of aluminum are available for temporary lines through the same suppliers.

Get the full story of the many benefits you get when you use portable piping of ALCOA Aluminum. Mail the coupon now to get your free copy of the descriptive booklet, *Portable Oil Country Service Piping*.

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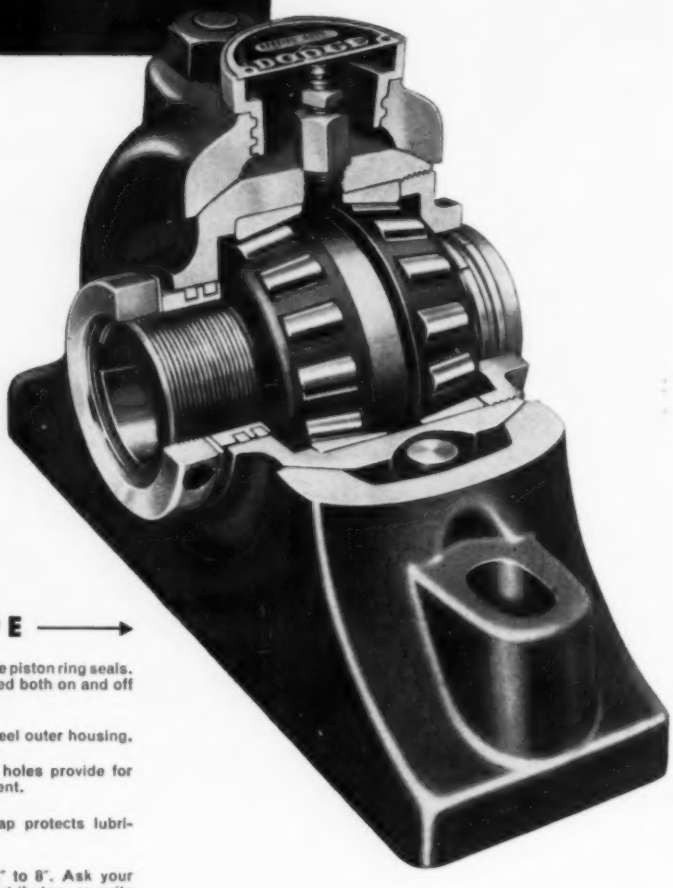
Timken Bearing Equipped

America's super-quality line—with a 34-year record of keeping performance *up* and costs *down!* Five types—to fit practically any service condition. All assembled, adjusted, lubricated and *sealed* at the factory for precision performance—long life—dependability.



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- Designed for extreme precision and high load capacities.
- Fully self-aligning.
- Special Duplex Timken Roller Bearing with tapered bore.
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- Special dust cap protects lubrication fitting.
- Shaft sizes 1¾" to 8". Ask your local Dodge Distributor—or write us for Bulletin A670 giving complete technical data on America's most complete line of mounted bearings.

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CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

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of Mishawaka, Ind.

JET SPEEDBOAT

Record Breaker

Donald Campbell of England is the world's record-breaker for speed in a jet-powered boat. He traveled 225.36 miles per hour in a test on Lake Conistono in England on September 19, 1956.

Meet Another RECORD-BREAKING JET

Security's jet bit S3-J wins increasing favor with Louisiana Gulf Coast drilling contractors.

Drilling Superintendent James Sharon (left) Continental Drilling Company, Inc., New Orleans, aboard one of Continental's drilling barges, "talks it over" with Security's Leroy Guidry.

Says Sharon, "We bought our first S3-J in Louisiana, about three years ago. Our rigs run more than 50% Security. Your rigside service can't be beat; and bit performance matches service." Good reasons why Security is *now 2nd in sales!*

Wherever you drill, experience that plus + bit of Security, product of vanguard engineering . . . sterling quality . . . worldwide uniformity . . . matchless rigside service!

✳S3-J Illustrated

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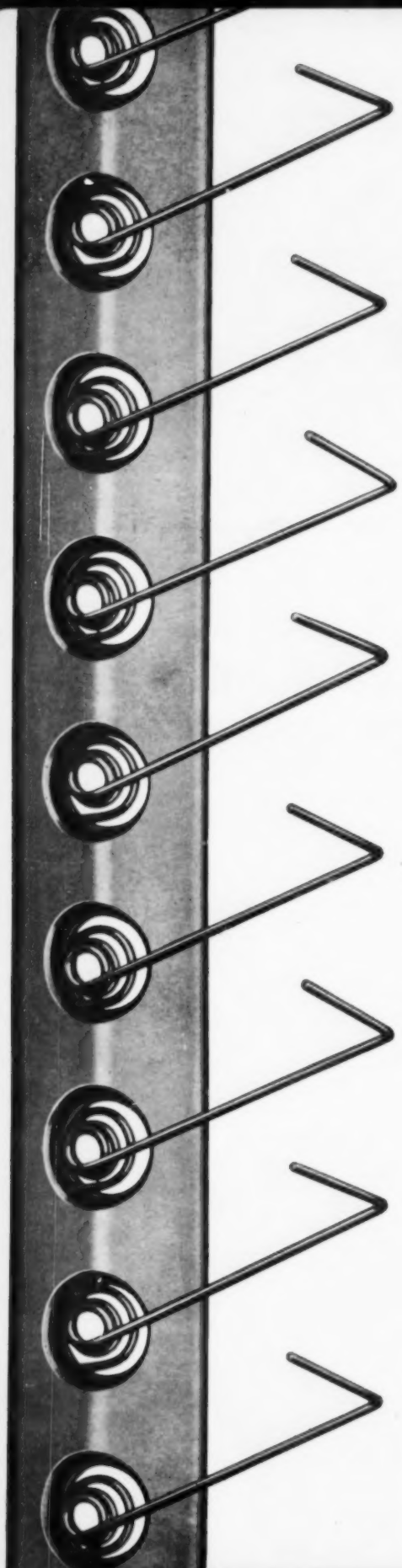

IS WALL SCRATCHING "POINTLESS?"

NOT WHEN YOU USE Baker ROTATING Wall Scratchers.

WITH "PLOW ANGLE" WIRES!

Operators who prefer "Rotating-Type" Scratchers will find the new Baker *ROTATING* Wall Scratcher (Product No. 903) far more effective than typical scratchers with "pointless" trailing wires. See in Fig. 1, how the right-angle bend at the ends of the wires in Baker *ROTATING* Scratchers provides a "plow angle" point which *must* dig in and effectively remove mud cake. Compare these results with the "pointless" action of trailing wires which are *merely dragged over* the mud cake without removing it; see Fig. 2.

Note also in Fig. 3, how the "plow angle" scratching point is maintained over a wide range of clearances—even under slim hole conditions—as each wire automatically adjusts to meet the wall of the hole.

Shock absorbing spiral springs, mechanically held by the *double* body thickness, prevent distortion of the scratcher wires both while running-in the hole and throughout the scratching operation.

Ask the Baker representative in your area for details of spacing and installation. Try this successful aid to "first-time" cementing.

If you prefer RECIPROCATING *Type Wall Scratchers, Baker Solid-Ring* SLIP-ON *Scratchers, or Baker* HINGE-LOK *Wall Scratchers will bring you* CONTROLLED SCRATCHING *by removing the mud cake only throughout the area to be cemented.*

BAKER OIL TOOLS, INC.

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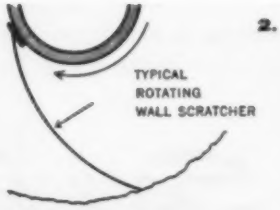

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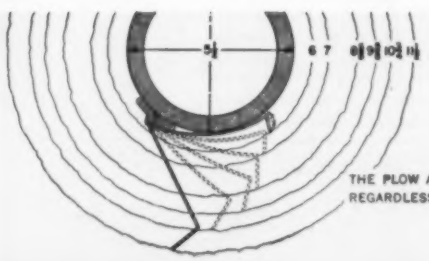
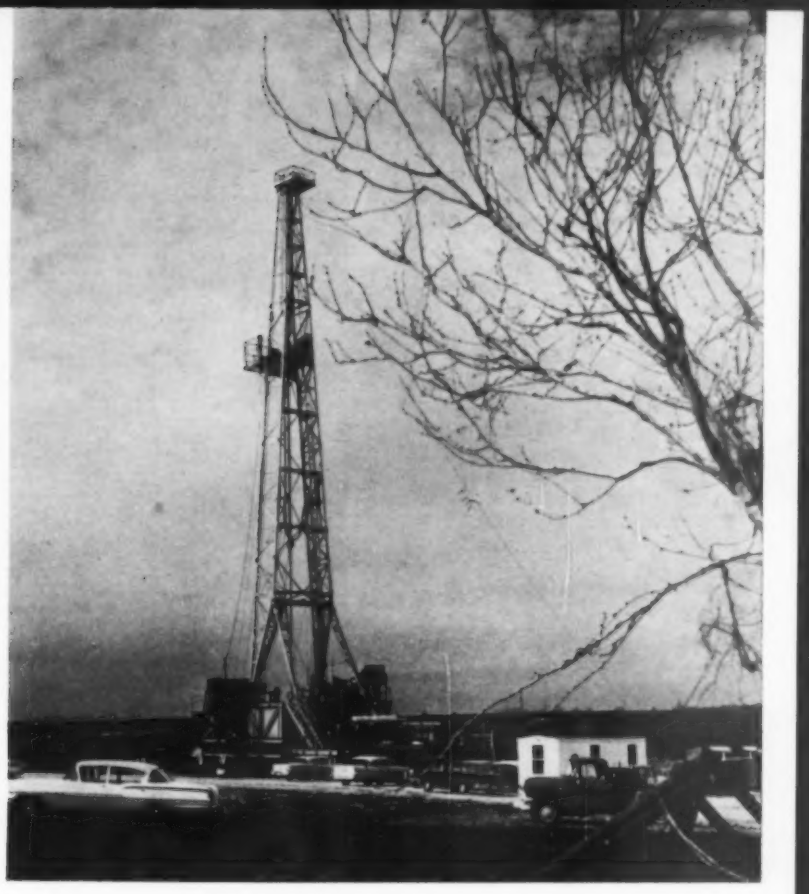




Buzzini Rig No. 8 looks like many other heavy duty rigs — but a closer view shows many refinements that have paid off.

ENGINEERING, INGENUITY PAY OFF ON BUZZINI RIG NO. 8

Outstanding Features:

- ★ *Rugged new automatic driller*
- ★ *Atmospheric cooling sections for engines*
- ★ *Remote recorder to plot block position vs time*
- ★ *Sub-floor mounted drawworks — at truck-bed level*
- ★ *Open substructure allows 15 ft headroom*
- ★ *Unitized catworks and rotary*
- ★ *Remote-controlled brake at sitting position console*

Driller's console empty while rig drills ahead. All controls are pneumatic.

Arthur P. Buzzini, *Vice President*
Buzzini Drilling Company
San Antonio, Texas

ASIDE FROM THE NEW AUTOMATIC DRILLER our engineers devised with the help of several instrument companies and the remote traveling block recorder, Rig No. 8 cannot be considered a new and completely different rig in its own right. It is rather an evolution of rigs — the latest but perhaps not the last — that started with Buzzini Drilling Company's Rig No. 5 in 1949.

At that time it was decided to deviate from the standard rig set up to achieve better economy of operation, greater ease in moving and setting up, and maximum operating safety.

From our standpoint, Rig 5 proved that the modifications we made (which

were publicized in industry literature) not only paid off but pointed the way to future modifications. Our Rigs 6 and 7 were constructed along the same lines as Rig 5, and in addition, modified during their operating life as needs and new ideas arose. Buzzini Rig 8 is a logical evolution of the preceeding rigs.

Substructure

Rig 8 has a 16-ft floor made up of a 7-ft sub-base and a 9-ft structure, each of which can be moved easily under any bridges or underpasses in this area. When the rig is assembled, and running, trucks or tractors can drive right up to the blowout preventers — the headroom beneath the floor is some 15 ft, and the only obstructions are the rathole and mousehole.

Drawworks at Truck-Bed Height

Setting the heavy drawworks high on top of the structure requires additional bracing in the substructure, and it considerably complicates the moving task. Actually, there is little reason to set it there what with the excellent remote controls that are available today. As a matter of fact, the only logical excuse for setting the drawworks on the floor of a large size rig is that the catworks is an integral part of the drawworks.

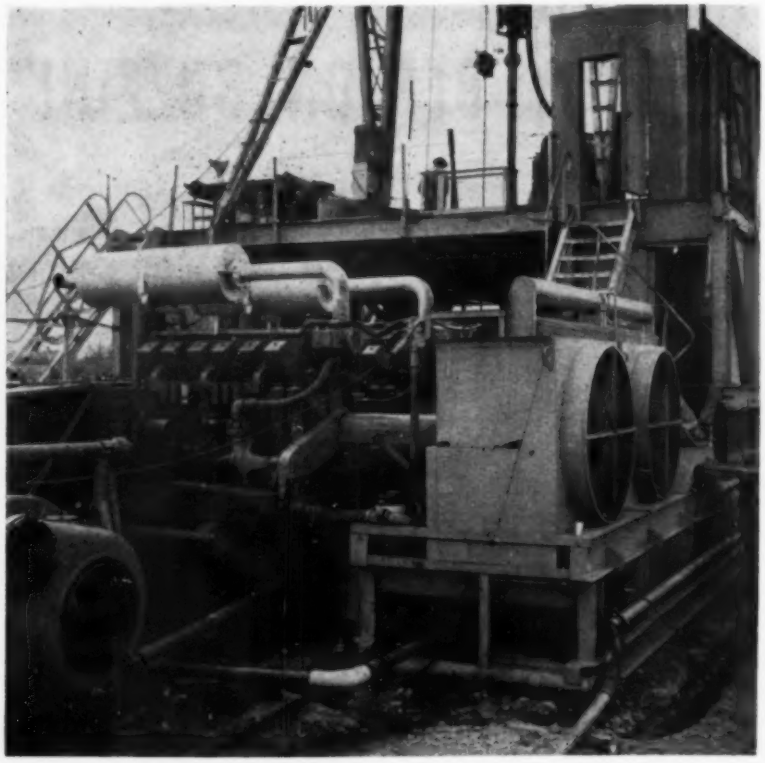
On Rig 8 we designed a substructure at low-boy height (44-in. above the ground). This required that the controls be remote in order that the driller could operate them from the floor. This required surprisingly few modifications. Clutch and throttles are operated by air on most standard rigs anyway, and it has been the drum brake controls that tied the driller to the drawworks. In 1949 we first tried air-actuated brakes, and nine years and four rigs later, they are still proving to be very satisfactory.

With the brake problem solved, the drawworks can be set under the floor and out of the way. This position allows us to realize these advantages:

1. Ease of placement and removal,
2. Less vibration,
3. Smaller and lighter structures,
4. More floor space for working,
5. Shorter belts for the pump drive, and
6. Better driller visibility.

The drawworks was further relieved of all operations except the raising and lowering of the drill pipe thus making it a lighter, simpler and more trouble free machine. In fact, it is now completely still except when it is lifting or lowering the drill pipe. The drawworks

Substructure is open — truck or tractor can get right up to the string of preventers — the only obstructions are the rathole and mousehole. Here, crewman is washing down the preventers after a round trip.



Atmospheric cooling sections replace radiators on the drawworks engines. By eliminating make-up water, scale problems were eliminated.

power is used only when hoisting so it is available to drive the main drilling pump. For greater flexibility the drawworks and pump are powered by a dual set of engines. The dual engines have many advantages. During rig up, tear down and other operations where full power is not required, only one engine can be used. An example of this is the standby pump. One engine is used for mixing mud, two for drilling. We have also noticed that two engines will pull together whereas three tend to be hard to control in unison.

ROTARY AND CATWORKS

To eliminate open or non spray lubricated chain drives the rotary is powered by a direct drive engine through a torque converter and a hydraulic tank transmission which gives three speeds forward and one reverse. The universal shaft drive runs under the floor to the rotary, which is also flush with the floor. The shaft drive eliminates side pull on the rotary thus extending bearing life.

Because the rotary engine must run only intermittently when tripping it was a logical source of power for the catworks. Catheads are mounted on the rotary unit and are easily controlled from the driller's position pneumatically. The rotary and catworks are, of course, unitized.

Rotary and catworks are unitized. Rotary table, engine and catworks are skid mounted, making up a structural member of the sub-structure. Catheads pull line away from the driller.

SOLUTION TO RADIATOR TROUBLES

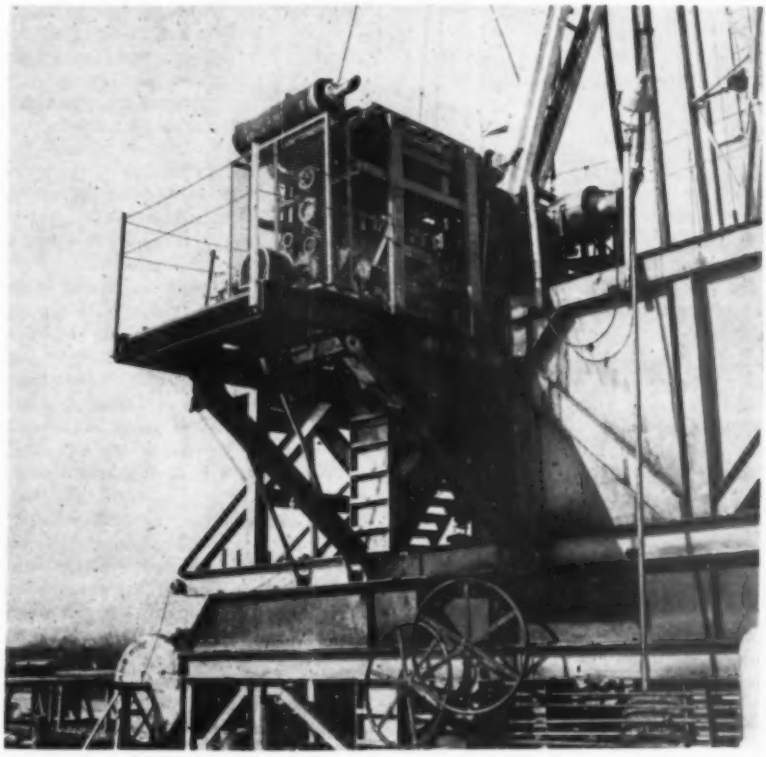
In South Texas there are many locations that require a set up with the engine radiators backed into the wind. A 20 mph breeze will effectively stall the air circulation through most radiators and a hot engine always means trouble. A non-directional cooler similar to those used on stationary compressor units driven by a universal shaft completely stopped all radiator and cooling problems. Make up water is almost nil virtually eliminating scale problems in the cooling system.

DUAL FUNCTIONS

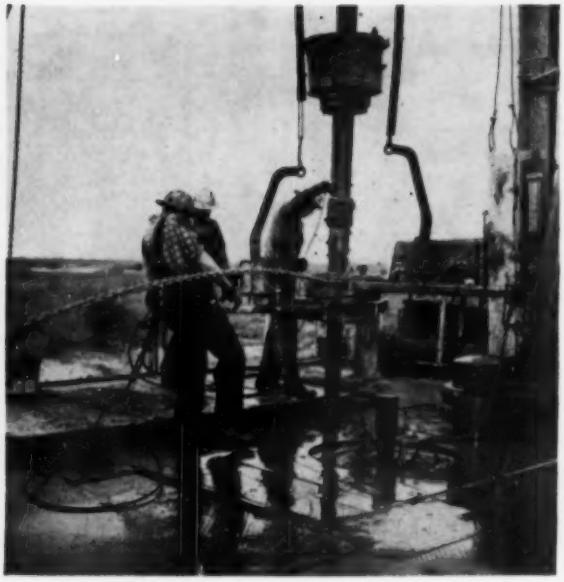
To carry out the theme of each piece of equipment doing a special job, the electric and air utility units, again dual, are mounted in a steel house. They must be available and always reliable in spite of the weather.

Drillers Console

To completely control the rig the driller is seated in a chair at a console. The pneumatic valves most often used are in two rows with those seldom used at either side. A hand throttle with a Vernier adjustment is used for drilling and a foot throttle for tripping. At the driller's right is the hand control for the drum air brakes; his left foot operates the magnetic particle brake.



Rotary and catworks engine overhangs the rig floor. Rotary has direct drive.



Crew spins kelly sub into drill pipe in mousehole. Catheads pull line away from driller to reduce potential hazard.

In the toolpusher's office, the position of the traveling block is dually recorded by instrument on wall.

Also, at his right is the blowout preventer operating panel, remotely controlling an accumulator unit off the floor.

The chair for the driller might seem to be a departure from tradition to some but a machine operator works more easily and is less tired when seated. Physical effort to operate any of the pneumatic valves can be performed by one finger.

Automatic Driller

We have always been concerned by the fact that the most highly trained man in the crew, the driller, stays so busy operating the rig while drilling that he has little opportunity to oversee the whole job. To release him from watching the weight indicator required an automatic driller.

Our first automatic driller operated the drum brakes. But after much trial and error and many modifications we devised a system that takes a signal from the drilling line tension to keep the desired weight on the bit. Drawworks drum brakes are not involved. When the master clutch is disengaged the automatic driller is engaged, controlling the feed-off through an air brake and drawworks shaft. The driller is now free to generally supervise the entire rig operation and he becomes once again a foreman rather than an operator.

Safety

The theme of Rig No. 8 development has been safety. In the design of the drum brakes the air is used to release the brakes; they are engaged by 2-ft long springs that travel ⅝-in. from release to full engagement. Air against a piston compresses the spring and releases the brakes; thus, an air failure would set the brakes. Backing this action are two more automatic safety devices. When the brake lever is fully depressed it bumps two valves open — one dumps all the air from the brake system in the event of an air valve failure, the other places full air pressure behind the brake cylinders to help the springs in the rare event of spring breakage. Both springs would have to break for brake failure as only one is needed to stop the drum.

Backing up the drum brakes is the magnetic particle brake. With the use of this device slips may be set at 13,000 ft without the use of the drum brakes. A light on the driller's console shows when this brake is available. A solenoid valve also gives an air warning if the electrical current is broken.

When the rig is drilling with the automatic driller in control, the magnetic particle brake is in the full "on" position — not to help the driller, but to be able to prevent the blocks from falling to the floor if the auto driller should fail. Company rules make it mandatory that some member of the crew be on the floor at all times when the rig is drilling to monitor the operation of the auto driller and to intercede in the event of a washout, twist-off or any other accident.

A flush unobstructed floor, catheads pulling away from the driller, and air slips are also important safety features.

Other Features

The toolpusher's office bunkhouse has two rooms; one contains four built-in bunks and an air conditioner, the other room contains a desk, a built-in stand-up table, and a bench. Built-in features make the whole setup easy to keep clean. Above the desk on the wall is a rig recorder which traces a duplicate chart of the rig operations. The chart records traveling block position vs time giving the pusher and the main office a record of trip time, bit performance, and any shut down time that might have occurred during a 24-hour period. Charts are sent to the main office and to the operator each day.

For the past year Rig No. 8 has been drilling Edwards lime wells to a depth of 11,000 to 12,000 ft. Its capacity is 13,000 ft with 4½-in. drill pipe. Drawworks is powered by two 605 hp gas-butane engines which also drive the 8 by 20-in. main mud pump. The standby pump is driven by two 276 hp engines. The rotary engine is rated at 248 hp. The preventers are two QRC ram-type units with a "doughnut"-type unit on top with choke manifold outside of the structure. Two 8 by 30 by 5 ft mud tanks complete the rig picture.

Rig No. 8 is not by any means the final answer, being only the present expression of our attempt to assemble and work better rigs for more efficient drilling. ★ ★ ★

Rising cost of oil operations has become a matter of serious concern for all of us. Just how serious is reflected in this recent statement by a Pan American Petroleum Corporation official: "The increase of steel prices effective July 1, 1957, was the third within the year. This raise caused average oil country tubular goods prices to increase $10.35 per ton. Thus, the total cumulative increase in cost of tubular goods during the year ending July 1 was an average of $33.50 per ton. We use about 62,000 tons of casing and tubing a year. That means an additional cost in a single 12-month period of over $2,000,000 for tubular goods alone."

The initial impact of this price spiral on the cost of various oil field items is difficult to measure. But a study of the rising costs of field equipment in recent years sounds an ominous warning of what lies ahead. To illustrate how operating costs are climbing, look at just one field in one area — the story is the same everywhere.

Spivey field in South Central Kansas was discovered just five years ago. Yet, in that short span of years since Spivey's discovery, costs of common items of oil field equipment necessary for normal field operations have registered astonishing gains. Sucker rod prices are up almost 38 percent. Oil string casing is up 41 percent. And price spirals aren't limited to our producing operations. Exploration, research, administration have all experienced similar expense increases. Wherever there are oil operations — in Wyoming, West Texas, or southern Louisiana — operating expenses are on the rise.

THE COSTS ARE UP ON EVERY ITEM, TOO. Up most are the fundamental items of oil field equipment that must be purchased in vast quantities . . . to replace worn or damaged equipment on existing leases and to equip new leases. Most of these items are made from iron and steel products . . . which have increased 30 percent in price during the five-year life of the Spivey field, as illustrated here.

As costs for supplies and equipment increase, so do operating costs. A prolonged era of constantly increasing costs for operations, with no more crude price increases than have been forthcoming in recent years, could offer a serious threat to the economic security of our industry.

In view of the present situation, it's important that every employee help in every way possible to get the most out of every operating dollar. There are several ways in which we can keep operating costs down. Here are a few:

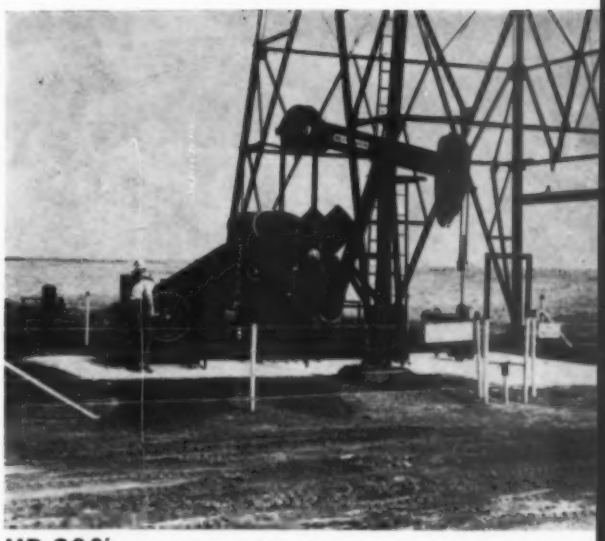
— A studied program for improved maintenance of tools and equipment so as to extend the useful life of these items.

—Special effort to salvage and place back in operation items which still have a measure of useful life left in them.

— Careful attention to equipment programs to avoid the possibility of unnecessary installations or replacements.

— Extreme care in operation of vehicles and machinery so as to avoid undue wear or damage.

— A thoughtful approach to every phase of operations aimed at checking the upward trend in operating expense.



UP 20% Engine which drives this pumping unit cost $1015 in 1952. Today, the price is $1225 . . . an increase of $210. Cost of pumping unit, itself, is up 18 percent to $3910. This is in the Spivey field of Kansas — but the price of the equipment is the same everywhere.

UP 9% Moderate price increase occurred on paint. Aluminum-type, mixed here by a roustabout in the Spivey field, was $2.75 . . . now same type is $3 per gallon.

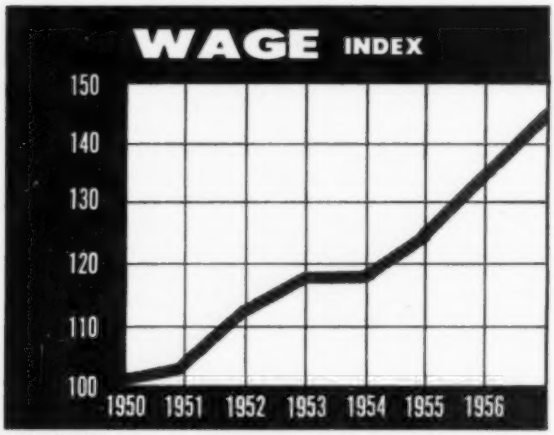
Chart illustrates spiraling costs of iron and steel products in recent years. Three steel price increases in a single 12-month period are responsible for violent upswing of steel's price index in the years 1955 and 1956.

UP 35% It's amazing to learn cost for wrenches and other miscellaneous items have risen as much as 35 percent since 1952.

UP 36% Five years ago this 3-in. valve sold for $218. Same valve today costs $298.

UP 38% Tubing has shown alarming increase. In '52 a 4300 ft string for a Spivey well cost $2710. That same string today would cost $3740 — up over $1000!

UP 30% In 1952 this high-pressure separator cost $1524. Now it's $2000.



UP 37% Wage costs have risen faster than crude price has increased. Wages since '50 are up 37 percent. Crude prices are up only 20 percent in this Kansas area.

FEW ITEMS HAVE ESCAPED

TRENDS OF INCREASED COSTS AREN'T LIMITED TO MAJOR PIECES OF FIELD EQUIPMENT . . . tank batteries, pumping units and the like. Less spectacular items such as stationery, office supplies, adding machines . . . yes, even paper drinking cups . . . have advanced 20, 30, even 40 percent in cost. True, these minor items represent but a minute fraction of field-wide operations costs. But on a company-wide scale, a 25 percent increase in one or more of these relatively insignificant office items adds additional thousands of dollars to our operating expense.

Yes, this problem of increased operating costs is serious, indeed. It requires *our* most careful consideration.

ACKNOWLEDGMENT. This article was adapted from the December 1957 issue of *Horizons*, publication of Pan American Petroleum Corporation, who granted its publication here.

★ ★ ★

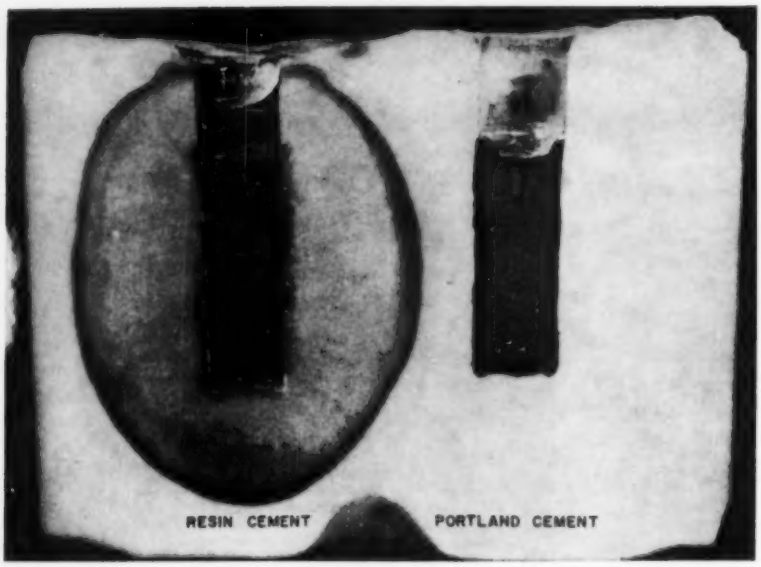
UP 24% Among smallest items purchased are wire staples for office use. But they aren't immune to cost increase — $45 per hundred boxes in 1952 to $56 per hundred today.

UP 15% Standard four-door automobile reflects more modest gain in price. Fleet price per unit is $2250 today. Comparable unit cost was $1950 five years ago.

UP 40% Adding machine, on which crude tallies are run, cost $100 in '52. It would cost over $140 to replace the same machine today.

UP 36% Pumper's doghouse that cost us $360 five years ago now has price tag of $490.

UP 26% Yes, even paper cups are up . . . from 38 to 48 cents a box. Nearly all stationery costs have risen.



Filtrate of resin cement slurry that is squeezed into formation will set up as does the plug itself, as illustrated in this salt block squeeze. Note the penetration.

James R. Williams Jr.
District Engineer
Halliburton Oil Well Cementing Company
Flora, Illinois

RESIN CEMENT Aids Waterflood Control

Test of time proves assistance in shutting off low-pressure producing and waterflood wells in Illinois

UNCERTAINTIES of waterflooding are being minimized by the growing use of resin-type cement which has proved itself to have necessary strength and resistance to meet most well conditions.

Thousands of gallons of resin cement which have been used in the Tri-State area over the past six years have shown the material to be excellent for aiding in water control of waterflooding. This success is due to its (1) high bonding and compressive strength, (2) resistance of oil well fluids and chemicals, and (3) filtrate which sets up within the formation.

Problems

Oil-displacement operations often present several problems for the operator. Among these problems are:

1. Injection wells may have a small portion of the formation absorbing a lion's share of water (resulting in both waste and lower recovery rates).
2. Loss can occur at the bottom of the hole, or at any point in the section, for that matter.
3. Non-producing formations may be flooded or allow water to rise to the surface.
4. Added to these basic problems are difficulties of working over a well for flooding or producing a new zone. Problems can arise in plugging back inside casing. Hole size and shot fractures may cause trouble during plugging back in open holes.

Tested in the Tri-State Area

To help overcome these problems the resin-type cement was developed by Halliburton Oil Well Cementing Company in 1945 and since that time it has gained wide acceptance in the Ohio-Indiana-Illinois area. While originally used in deeper wells along the Gulf Coast, it was later modified for the lower temperature conditions that exist in the Illinois basin.

Characteristics

This material is a combination of resins, water and portland cement which may be pumped or placed into the bore hole or annulus with a dump bailer to assist shutting off low-pressure producing or water flood wells.

Adding resin to the cement slurry will reduce the weight to 14 lb per gal but does not otherwise alter the mixing characteristic from that of regular portland cement.

The volume of resin cement slurry required for a given job will usually vary the mixing technique. Smaller batches are frequently mixed by the dump bailer method while larger volumes can be conveniently mixed and pumped with a regular cementing unit.

New Material Formed

The combination of water, resin and portland cement produces a new type of composition having properties different from conventional water-cement slurries. Resin cement may be classified as a low fluid loss slurry. It differs from other types of cement slurries in that the filtrate squeezed into a formation under pressure will actually set up as does the plug itself, providing a better bond and an impermeable zone around the cement. (This is illustrated in the salt block squeeze in Photo 1.)

Fluid loss under pressure occurs when the liquid phase of the slurry is forced into the first porous zone contacted. Result is a filter cake formation

as the fluid escapes, limiting the amount of fluid entering the zone.

The liquid resin will usually penetrate two or three inches before the filter cake restricts flow. The liquid phase generally bonds oil, gas or water sand and aids locking the bore hole plug to the formation. Voids or fractures may however prevent the resin filtrate from acting the same in both high and low permeability zones.

High pressures are not required to squeeze the resin from the mixture. Often, a differential of 1000 psi is sufficient.

The time required for setting will vary with the temperature of the formation but can be adjusted by varying the formulation of the resin cement. The standard mixture is normally recommended in areas where bottom-hole temperatures range from 80 to 120 F. In general, four to six hours is enough time to allow before measuring the height of the plugs but 24 to 48 hours are needed before proceeding with further operations.

The compressive strength of resin cement is ample for use in most wells. It has no shrinkage upon setting and its excellent bonding properties make it a superior sealing material for wells. Any plug or shut-off with the material will usually be permanent and impermeable since the set resin cement and fluid resin filtrate resist all attacks from oil, gas, salt water, and acids.

J. R. Williams Jr. *is a BS graduate from the Pennsylvania State University, 1951, with a degree in petroleum and natural gas engineering. He joined Halliburton Oil Well Cementing Company upon graduation and, after a period of training, was made field engineer at Flora, Illinois. He has been district engineer at Flora for the past five years.*

Application Methods Vary

Usually a dump bailer places the material where it is desired. The bailer is set on bottom to cut a metal disc and "dump" the contents. Special bridging plugs can run under the bailers and the material is then dumped at any point in the pipe or open hole.

Dump bailers are available in most areas to fit all hole and pipe sizes and up to 75 gal of material can be run at one time.

The trucks are equipped to mix the materials, pressure the casing to 1000 psi and measure the amount of fill-up obtained.

For larger quantities resin cement can be mixed and pumped by standard cementing units. The cement may be pumped through an open-ended tubing or a retainer and squeezed into the desired zone. The only difference between a resin cement job and one with neat cement is that resin cement may be pumped a longer time and will probably require less squeeze pressure.

Resin cement is often used by well owners to follow or "tail-in" regular cementing jobs. The resin material is placed around the casing shoe and part way into the annulus. This gives a good seal around the shoe or between perforations.

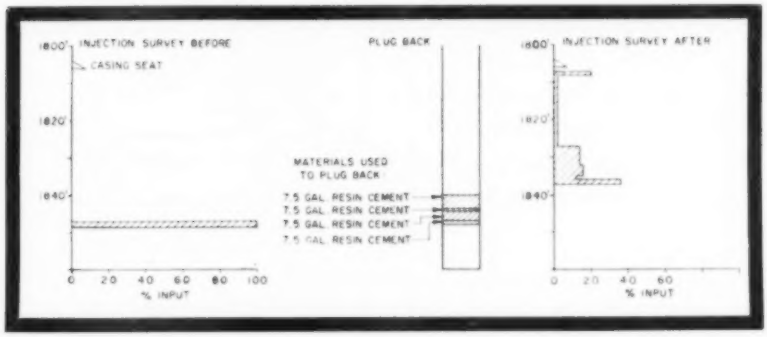


FIG. 1. **Water injection surveys,** measuring water input rates and locations using radioactive tracers and gamma ray counter. In this well the resin cement was dumped in 7.5 gal slugs to even water distribution and effect a good bottom shut-off.

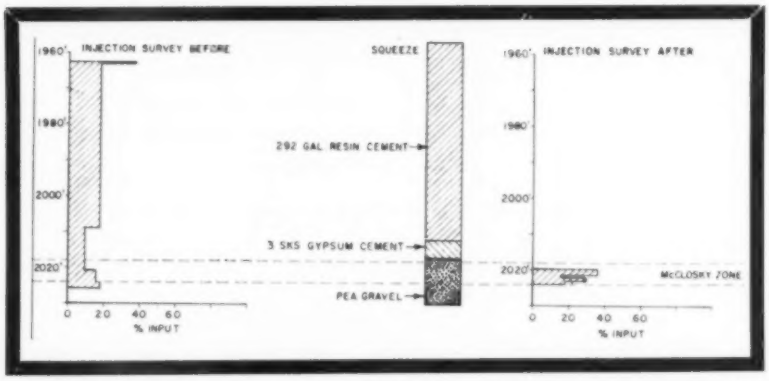


FIG. 2. **Water injection surveys,** using radioactive tracers and gamma ray counter, revealed that only 38 percent of the water was entering the desired interval. The water, being lost to a hole near the casing shoe, was stopped by plugging back with pea gravel, topping with 3 sacks of gypsum-type cement and then squeezing 292 gal of resin-type cement. Effectiveness of the seal is seen in the injection survey after the job.

Typical Resin Cement Uses

Simple plug back jobs are often used in water floods to aid shutting off a lower zone when the upper zone is produced or injected. On longer plugged sections, regular or gypsum cement is set and capped with resin cement. Sometimes it's better to squeeze the whole section with resin cement and then drill out to the desired depth.

Example: Conversion of an old McClosky producing well into an Aux Vases injection well would be done in this manner – the McClosky interval is between 3100 and 3110 ft, while the Aux Vases runs from 3065 to 3075 ft. The well is cased with 5½-in. pipe to a total depth of 3140 ft.

Gravel could be used to plug back the casing to 3120 ft with a sack of gypsum-type cement sealing the gravel to 3111 ft. A 30-gal batch of resin cement could then be put in and squeezed with an expected loss of between 10 and 15 gal of material. This would leave the top of the plug at a point from 3096 to 3101 ft.

Penetration of the filtrate or fluid parth of the resin cement would help seal off channels that could direct water away from the Aux Vases flood.

(Continued on Page B-34)

New approach improves accuracy of

POROSITY DETERMINATIONS FROM NEUTRON LOGS

Determination of low and high porosities now possible through application of a new form of a common deflection/porosity equation

A. A. Brown
Senior Formation Evaluation Geologist
The California Standard Company
Calgary, Alberta
and
Brian Bowers
Logging Engineer
Imperial Oil Limited
Calgary, Alberta

IT IS OFTEN possible to estimate porosity from the neutron log with improved accuracy by making simple changes in certain well-used equations. One of the most common involves plotting neutron deflection versus the log of porosity; this permits a straight line plot for a limited range of porosity only. However, plots of the logarithm of neutron deflection versus porosity on a linear scale are found to be straight lines over a wider range of porosity.

The neutron log is widely used throughout the petroleum industry for quantitative estimation of porosity. For this purpose neutron logs are commonly calibrated with a logarithmic porosity scale. Porosity, obtained usually from core analysis, is plotted against the equivalent neutron log deflection, and a "best fit" straight line drawn through the points so obtained. This line can be represented mathematically by an equation of the form:

$$\text{Log}\,\phi = -mN_d + K \quad . \quad . \quad . \quad (1)$$

ϕ = porosity
N_d = neutron log deflection
$-m$ = slope of "best fit" line
K = a constant

Although Equation 1 has been widely used in neutron log interpretation no theoretical justification for its use has been published. It is obvious that an equation of this form is not applicable to very low porosities, and experience has demonstrated that it is also inaccurate for high porosities.

The relationship between porosity and neutron log response is governed by the neutron distribution around the neutron source. Several investigators have studied this distribution and have deduced equations describing it. These equations suggest a better form in which porosity/neutron log deflection correlation curves can be plotted.

A neutron logging tool consists essentially of a source of fast neutrons

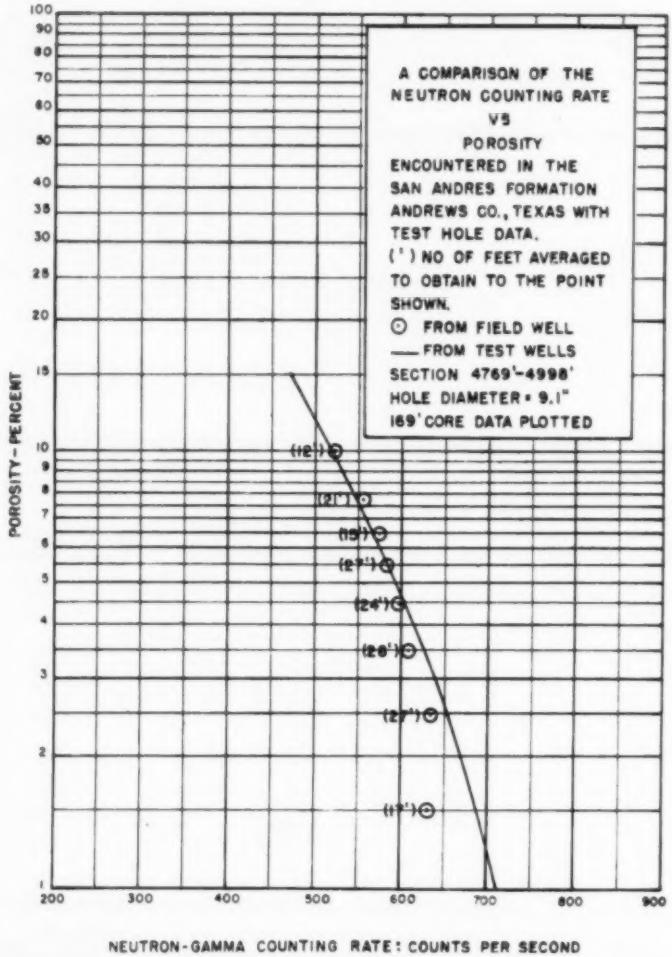


FIG. 1. **Diagram from a calibration chart booklet.** Calibration points an average of several measurements. Note the deviation when attempting to plot these measured points using Equation 1.

Presented as "The Relationship Between Neutron Log Deflection and Porosity" at a recent logging symposium in Calgary, Alberta, sponsored by the Canadian Well Logging Society.

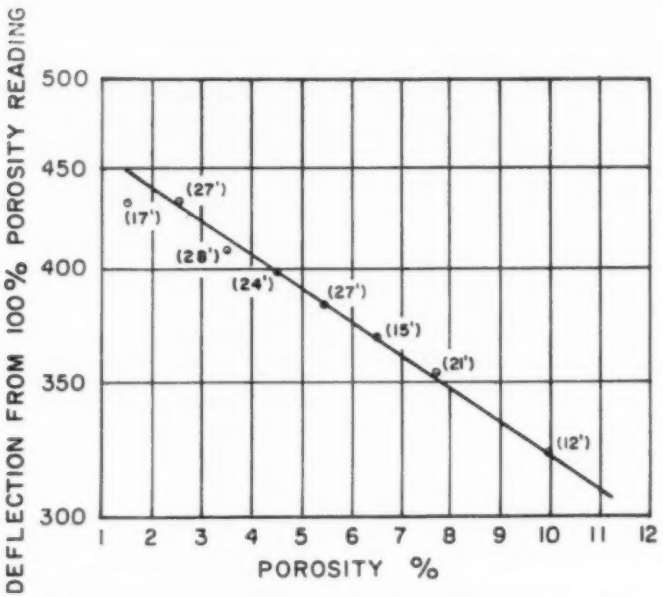


FIG. 2. **Same points** (used in Fig. 1) are replotted using Equation 4. Neutron log deflection is measured from the log deflection for a porosity of 100 percent.

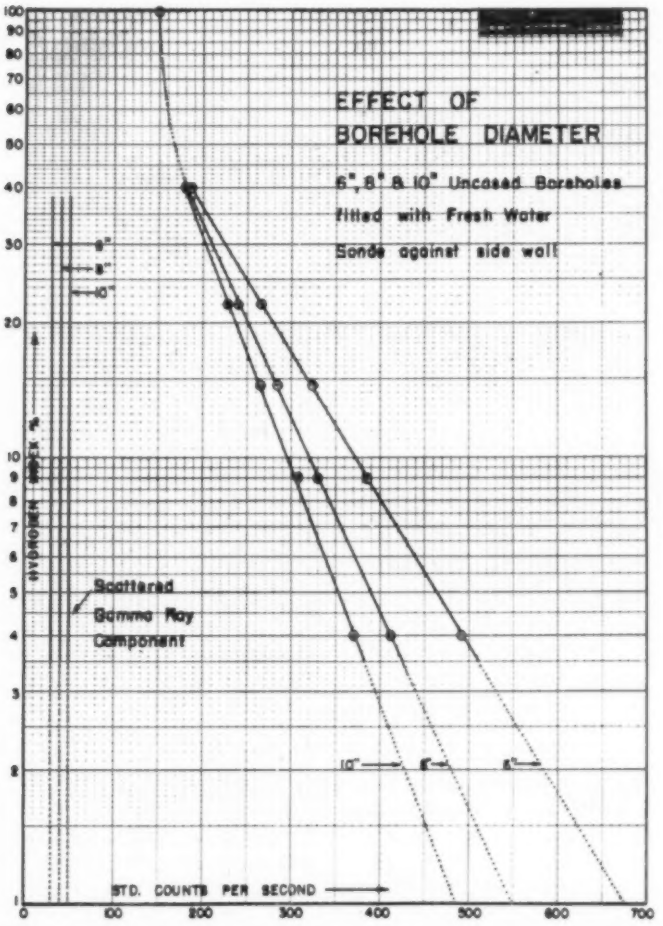


FIG. 3. **One of a series** of well logging company graphs is used here to plot deflection against the logarithm of the porosity for five porosity values, measured using limestone blocks in a test pit.

and a detector located at a certain distance from the source. The neutron source and detector type vary from logging company to logging company. Some companies employ detectors which record gamma rays of capture while others measure thermal neutron or fast neutron distribution. However, the porosity/deflection relationship is not greatly different for the several detector types.

Theoretical Considerations

Bush and Mardock [1] have stated that the intensity of induced gamma radiation in a cavity of rock at a distance "r" from a point source of fast neutrons is given by:

$$I = \frac{SQC}{r^2} e^{-ur} \quad . \quad . \quad (2)$$

S is Source strength

Q is a factor due to the neutron energy distribution of the source

C is a quantity which corresponds to the average effectiveness with which the elements present in the rock convert the neutron flux into a gamma ray flux. It varies with the chemical composition of the rock.

u is a factor related to the "thermalizing" efficiency of the rock. It is principally a function of the hydrogen content of the formation.

r is the distance from the source.

e is the base of natural logarithms.

If the above equation is applied to neutron-gamma logging, and it is assumed that the detector has an approximately linear response to gamma radiation, Equation 2 is of the form:

$$N_d = ke^{-ur} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where:

N_d is the neutron log deflection

k is related to the source strength and type, the geometry of the logging sonde and to the formation chemistry. (These values will be constant for a particular sonde and lithology.)

u is related primarily to porosity for a non-shaly rock containing a hydrogenous liquid (oil or water) in its pore space.

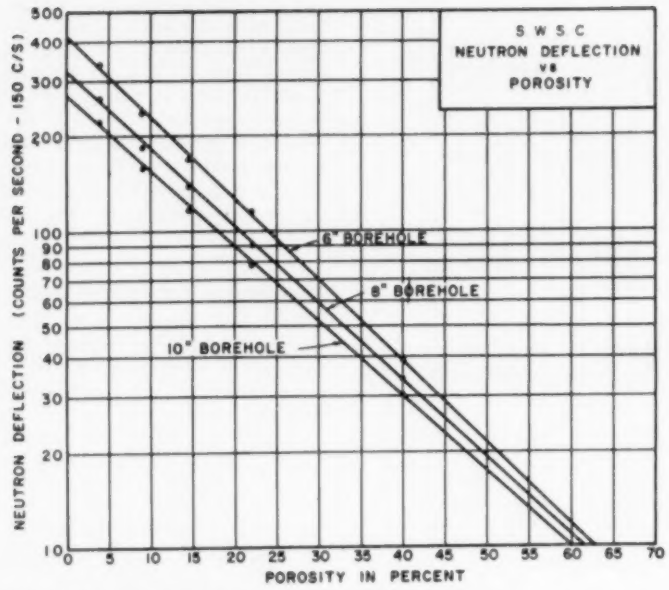


FIG. 4. **For porosities beyond the measured range,** Equation 4 gives more reasonable results when extrapolated, than that of Fig. 3, using Equation 1.

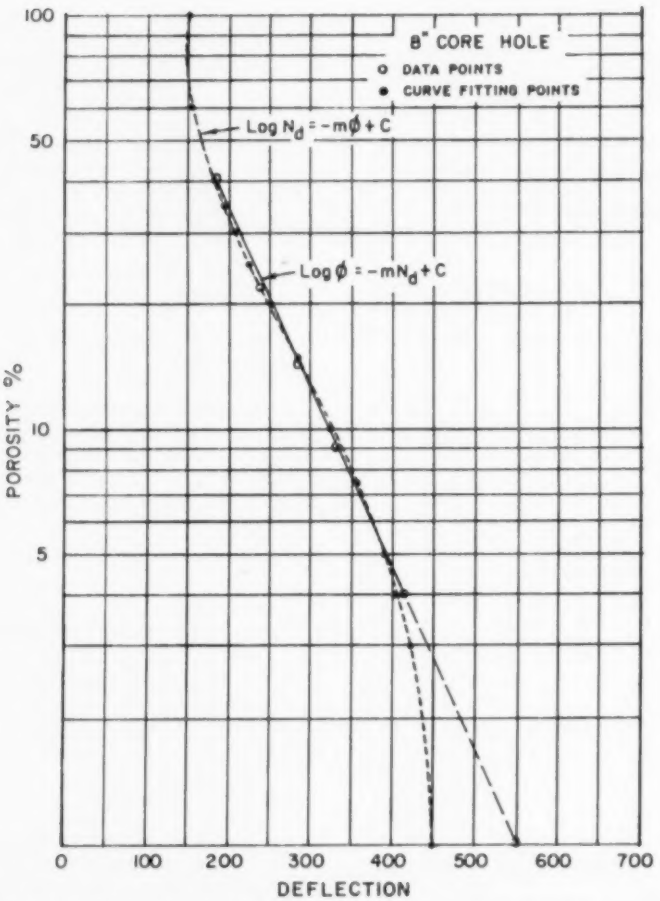


FIG. 5. **Calibration curve** of Fig. 4, for an 8-in. borehole, replotted for comparison with service company calibration curve.

r is a constant for a particular logging sonde.

Equation 3 suggests that the relationship between porosity and neutron/log deflection for the neutron-gamma ray device is more nearly of the form:

$$\text{Log } N_d = -m\phi + K \quad . \quad . \quad . \quad (4)$$

rather than the commonly used:

$$\text{Log } \phi = -mN_d + K$$

It is realized by the authors that Equation 4 is a much simplified explanation of a complex phenomenon. More rigorous equations describing neutron flux distribution (Equations 3 and 4) lead to complex equations for neutron log response which cannot be simplified to the form of Equation 4.

An empirical investigation of the utility of this equation was made. It was found that Equation 4 describes the response of neutron logs to porosity more accurately than the commonly-used Equation 1. The empirical investigation included:

1. A study of published porosity/deflection data to see if it fitted the relationship Log $N_d = -m\phi + K$.
2. Application of Equation 4 to field problems.

When neutron deflection is plotted on a logarithmic scale, it is essential that deflections be measured from a proper reference point. The most suitable log zero for this purpose has been found to be the log deflection opposite a porosity of 100 percent. The value of this log reading has been determined by each service company for its own logging sonde, by measuring the log response in a large tank of water. This zero value is approximated closely by the response of the sonde opposite a deeply caved interval.

Empirical Study

Equation 1 and Equation 4 have been applied by the authors to all readily available porosity/neutron log response data. Some of these data are illustrated below.

Fig. 1 is from a calibration chart booklet published by well logging service company "A," for their neutron-gamma log. On this diagram a number of points are plotted of averaged core porosities versus averaged neutron log deflections opposite the cored intervals. The calibration points are each an average of several measurements. It is obvious that the measured points do not fit Equation 1. Fig. 2 shows the same points replotted to test if Equation 4 fits the data. There is excellent

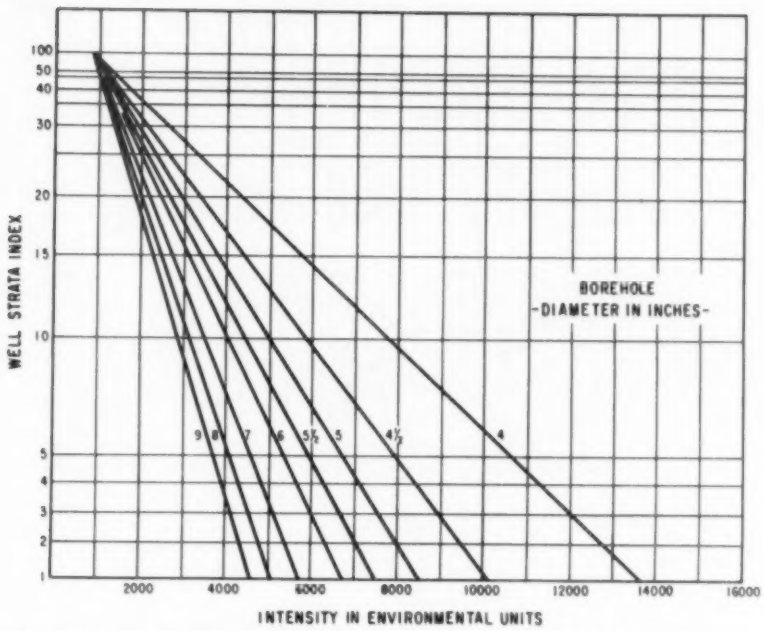


FIG. 6. Neutron log calibration chart of another radioactivity logging company with a 100 percent porosity reading at the vertex.

agreement between core porosity and neutron log deflection, when it is assumed the logarithm of the neutron log deflection is proportional to the porosity. Neutron log deflection in Fig. 2 is measured from the log deflection for a porosity of 100 percent.

Fig. 3 is one of a series of graphs issued by well logging service company "B" as calibration charts for their neutron log. On this graph, neutron log deflection is plotted against the logarithm of the porosity for five porosity values, measured using limestone blocks in a test pit, for 6, 8 and 10-in. boreholes. These data appear to confirm Equation 1. However, they can be replotted with acceptable precision in the form of Equation 4, as is shown in Fig. 4. For porosities beyond the measured range, Equation 4 gives more reasonable results when extrapolated. This can be seen in Fig. 5, which shows the calibration curve of Fig. 4 for the 8-in. borehole, replotted for comparison with the service company calibration curve.

Fig. 6 is a neutron log calibration chart of RA logging company "C." Fig. 7 shows the curves of Fig. 6 replotted on semi-log graph paper, with logarithm of the deflection (from the 100 percent porosity reading) plotted against porosity, on a linear scale. It can be seen that the calibration curves appear as a family of parallel straight lines when replotted in this form. When one of these calibration curves has been established, only a single porosity/deflection point is needed to establish each of the other calibration curves. This suggests a simplified method of calibrating neutron logs for various hole sizes, when a calibration curve for one hole diameter is available.

Equation 4 contains two unknowns: "m" which is governed by the geometry of the logging sonde and "K" which is mainly influenced by conditions in the borehole. The value of "m" for a particular logging sonde may be determined by means of a "calibration curve" (i.e. an accurate plot of log N_a versus porosity). The value of "K" is dependent primarily upon the hole conditions and must, therefore, be evaluated for each new hole condition, e.g., change of hole size, effects of casing and cement, etc.

A successful method of estimating porosity from the neutron log makes use of a zone of known and constant porosity over a wide area (e.g., "Red beds" in Saskatchewan) as a neutron log calibration point. This zone of known porosity may be used to evaluate factor "K." The point of known porosity is plotted versus its corresponding deflection on semi-log graph paper and a line is drawn through this point which is parallel to the calibration curve of the instrument established for another set of borehole conditions. This new line is then the correlation curve for the new borehole conditions. In Fig. 8 is seen an illustration of the accuracy which can be obtained by constructing porosity/deflection correlation curves in this manner.

Conclusions

Plots of neutron deflection versus the log of porosity are straight lines for a limited range of porosity only. Plots of the logarithm of neutron deflection (neutron deflection being measured

Albert A. Brown *obtained his MSc degree in geology and mathematics from the University of New Brunswick in 1950, and joined the California Standard Company, Calgary. He is presently senior formation evaluation geologist with that company. In 1955 he helped organize, and was first president of, The Canadian Well Logging Society.*

Brian Bowers *was graduated from the University of Birmingham (England) with a BSc in petroleum engineering in 1956. He joined Imperial Oil Ltd. in that year and has worked in the field and in the research technical service laboratory. He is now employed as a logging engineer in the regional reservoir section at Calgary.*

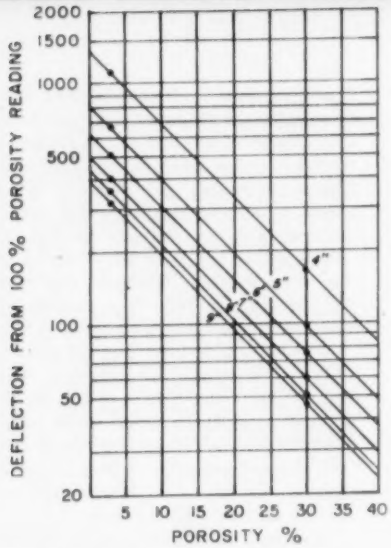


FIG. 7. **Curves** of Fig. 6 replotted with the logarithm of the deflection plotted against porosity, on a linear scale. The calibration curves now appear as a family of parallel straight lines in this form.

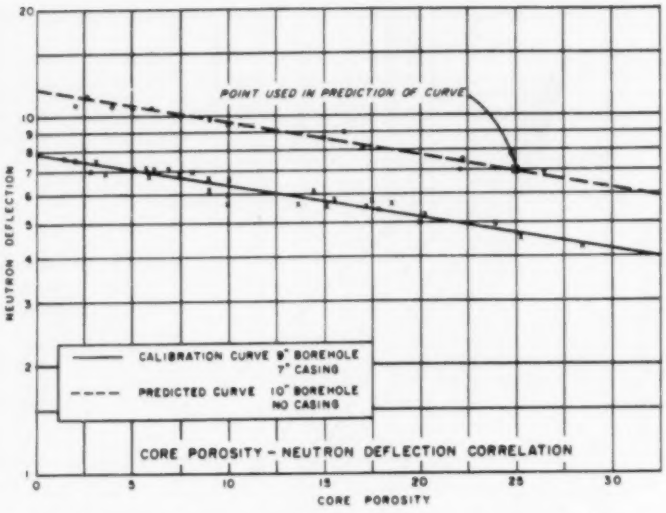

NEUTRON DEFLECTION
POINT USED IN PREDICTION OF CURVE
CALIBRATION CURVE 9" BOREHOLE 7" CASING
PREDICTED CURVE 10" BOREHOLE NO CASING
CORE POROSITY – NEUTRON DEFLECTION CORRELATION
CORE POROSITY

FIG. 8. **Accuracy** that can be obtained by constructing porosity/deflection correlation curves is illustrated here.

from the "100 percent porosity" reference line) versus porosity on a linear scale are straight lines over a wider range of porosity; using these plots, it is often possible to estimate porosity from the neutron log with improved accuracy.

The setting up of neutron log calibration curves for a range of borehole conditions, using a single reference point of known porosity, is feasible for some logging sondes.

Acknowledgments

The authors wish to thank the managements of Imperial Oil Ltd. and California Standard Company for permission to publish this paper.

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★ ★ ★

(Continued from Page B-29)

Bottom-shut-off is a second type of job that has been successfully completed with resin cement. In this operation, water production is shut off at the base of a zone or injection wells are protected against excessive water loss by sealing off an entire zone. These zones are usually located by radioactive isotope surveys. (See Fig. 1.)

Here's an actual well experience: A Benoist injection well was surveyed using radioactive tracer and a gamma ray counter lowered into the well. The survey showed that all of the injection water was leaving the bore hole at the bottom two feet of the producing formation. Resin Cement was dumped 7½ gal at a time to even water distribution and close the fractured zone. The plug ran six feet above the loss zone.

The radioactive log run several months later showed that water was now entering the sand as desired. Resin had penetrated the sand face and sealed the hole, preventing any water loss to the bottom of the zone.

Zones of loss within formations sometimes occur. Sealing a zone of this type involves isolating it as much as possible. From below, protection should come from a gravel and gypsum cement plug and from above, fill-up should be controlled.

The resin dumps need to be small and sufficient dumps made until the material is placed one to three feet above and below the water zone. The necessary pump pressure should be kept on the resin while it sets. After waiting 24 hours, careful drilling through the resin cement plug will open the hole from top to bottom. But if the vertical permeability is low enough to prevent free water movement around the formation, a seal off should be obtained. Obviously, this is more effective in open hole than through perforations.

Casing shoe leaks can often be sealed in the same manner as described above. The producing formation should be protected by a gravel and gypsum cement plug within two feet of the shoe. Then resin cement is dumped and squeezed until the material is set. Repeating this until the material is filled up to the casing, the set material can be drilled within 24 to 48 hours and the well put back in operation.

A similar job may be done if a large open hole section is taking water and a zone below is to be flooded. This permeable zone between the injection zone and the casing should be shut off.

Here's how: The Blank No. 1 has 7-in. casing set at 1962 ft and total depth is down to 2033 ft. A McClosky limestone zone needs flooding between 2018 and 2024 ft. When the well is surveyed (see Fig. 2) findings show that only 38 percent of the water is entering the McClosky interval and the rest is going through the hole near the casing shoe. Setting a liner is deemed impractical, so the space to 2018 ft is plugged back with gravel and to 2012 ft with three sacks of gypsum cement. Next 292 gal of resin cement are placed and then loaded with water to put pressure on the material. The material fills up 15 ft into the casing and when drilled out to the bottom a survey shows that the injection rate into the McClosky at 2022 to 2026 ft is moving steadily.

Special Problems

Sometimes it's desirable to change the fluid loss characteristics of resin cement to fit permeability and porosity conditions. That is, a low fluid loss material is used in zones with low permeability and porosity while a high fluid loss material is used in those zones with high permeability and high porosity.

In other cases it may be a very useful property for selective plugging where a deep, penetrating seal is needed. Controlling this characteristic of resin cement is possible, but the well owner should use it carefully because of difficulties of knowing the zone's permeability and porosity. ★ ★ ★

An impressive history of . . .

LIGHTWEIGHT DRILL PIPE IN SLIM HOLE DRILLING

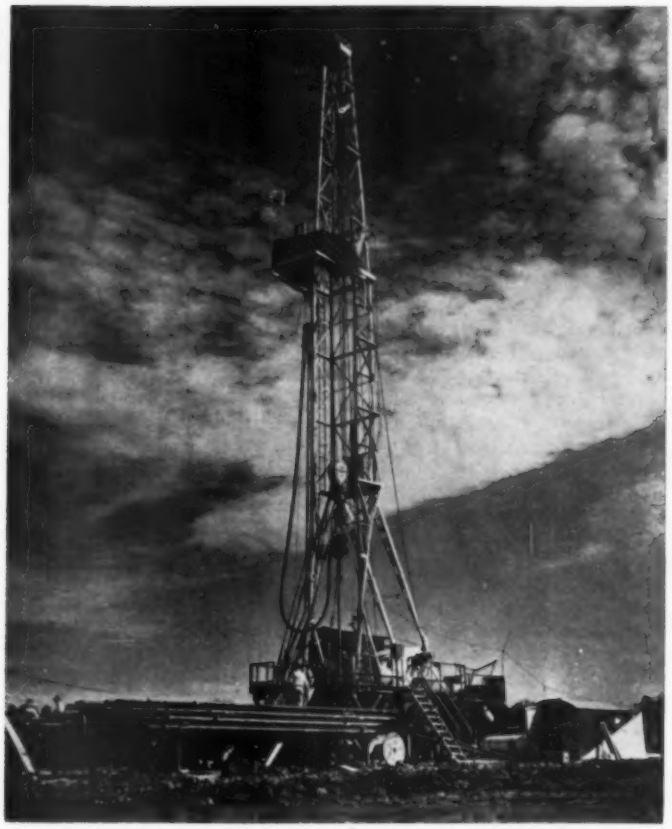


FIG. 1. **Woolf & Magee, Inc.** has equipped this trailer-mounted cantilever drilling rig with a drilling string of 2⅞-in. OD, 6.5 lb-per-ft, N-80 tubing.

By the end of 1957, Woolf & Magee, Inc. had drilled 44 wells for a total of 275,240 ft with 2⅞-in. tubing . . . without a hitch

J. W. Arnold
Woolf & Magee, Inc., Tyler, Texas

WITH THE PURCHASE of a third slim hole rig in May 1955, Woolf & Magee, Inc., began using a drilling string of 2⅞-in. OD, 6.5 lb-per-ft, N-80 tubing for drilling purposes. The first two slim hole rigs assembled by Woolf & Magee were equipped with strings of 2⅞-in. OD, 10.40 lb-per-ft, grade E drill pipe with API internal flush tool joints. The decision to experiment with 2⅞-in. tubing was reached in an effort to improve on three critical factors: Hydraulics, weight, and initial cost.

Briefly, it was the intention to assemble this string as cheaply as possible, experiment in drilling slim holes, salvage the tubing for production purposes if unsatisfactory for drilling, or continue to use the string for drilling purposes as long as possible and then use for production purposes should its condition permit. This string of tubing is still in service and, as of January 31, 1958, has drilled 44 wells for a total of 275,240 ft of hole. The record has been accomplished without a single failure in either the tubing or the tool joints.

Composition of Drilling String

Specifications of the tubing and tool joints are:

Tubing: 2⅞-in. OD, 6.5 lb-per-ft, N-80, EUE, seamless, range 2, 8 round thread.

Tool joint: 2⅞-in., API internal flush tubing tool joint, 4⅛-in. OD, 2⅛-in. ID, threaded for application on 2⅞-in. API EUE tubing.

Fig. 1 shows a cutaway view of the tool joint with the major joint dimensions. The tool joints were applied with a controlled torque makeup varying from a minimum of 3500 ft-lb to a maximum of 4500 ft-lb. The joints were neither counterbore-welded nor given any application of hard metal.

In discussions prior to assembling this string of pipe, the probability of last engaged thread failures was stressed at every opportunity. However, a desire to be able to use the tubing for production purposes with a minimum of conversion difficulty should it prove unsuccessful in drilling operations led to the decision merely to buck on the joints.

Drill collars used with the tubing string consist of eight 30-ft by 4¼-in. OD by 2⅛-in. ID flush type drill collars with 2⅞-in. internal flush boxes and pins. For use in 6⅛-in. holes where additional weight is required, a string of twelve 30-ft by 5-in. OD by 2¼-in. ID drill collars with 3½-in. boxes and pins is available.

Rig Specifications

Derrick: 94 ft, trailer-mounted cantilever drilling mast, 300,000-lb capacity, 8-ft 8-in. substructure.
Power: One 6-cylinder, natural gas or butane engine 212 continuous hp.
Pump: 7¼-in. by 12-in., skid mounted.
Rotary: 17½-in., 200-ton capacity.
Traveling block: 100-ton capacity.
Hook: 60-ton capacity.
Swivel: 60-ton capacity.

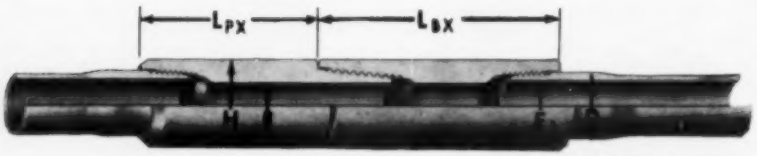
A summary of the drilling record to January 31, 1958, is shown in Table 1. Thirty-four of the 44 wells have been drilled within a 60-mile radius of Natchez, Mississippi, with most of the wells in this area testing the Wilcox formation. The remaining 10 wells include four wells in east-central Louisiana, one in south Louisiana, and five in Mississippi, northwest of Jackson, Mississippi.

Five of the wells have been drilled below 8500 ft and the record depth is in Cameron Parish, Louisiana, in a well drilled to 9960 ft.

The average depth of wells drilled

TABLE 1. Summary of Wells Drilled with 2⅞-In. Tubing.

Hole Size in.	Number of Wells	Total Footage Drilled ft	Total Rotating Hours hr	Average Depth Drilled ft	Average Hours per Well hr	Avg Footage per Rotating Hour ft
4¾	1	7235	618	7235	618	11.71
5⅝	28	183,787	4294	6564	153	42.80
6⅛	14	81,228	1923	5802	137	42.24
8¾	1	2990	52	2990	52	57.50
	44	275,240	6887	6255	157	39.97



Courtesy Reed Roller Bit Co., Houston,

FIG. 2. **This is the tool joint** used in the drilling string of 2⅞-in. tubing. Dimensions of the joint are:

Pipe Upset ID (E_1) in.	Pipe Upset OD (D_x) in.	Tool Joint ID (E) in.	Tool Joint OD (H) in.	Tool Joint Minimum OD in.	Pen Length (L_{px}) in.	Box Length (L_{bx}) in.	Weight Per Pair lb
2.441	3-3/32	2⅛	4⅛	3⅞	6¾	10¼	39

with the tubing is 6255 ft. This figure compares with an average depth of 5100 ft in 150 slim holes drilled by Woolf & Magee using 2⅞-in. OD, 10.4 lb-per-ft drill pipe. The explanation for this greater depth range lies in the weight and hydraulic advantages of the tubing. For this reason the tubing string has been used on all of the deeper slim holes drilled by the company.

Drilling Practices

The average operating conditions imposed on this tubing string may be summarized as:

Weight on bit: 2000 to 10,000 lb.
Rotary speed: 120 to 180 rpm.
Circulating rate: 140 to 180 gal per min. (4¼-in. liners).
Annular velocities — 5⅝-in. hole: 150 to 190 ft per min.
Annular velocities — 6⅛-in. hole: 120 to 150 ft per min.
Jet velocities — 3 5/16-in. jets: 195 to 250 ft per sec.

Two allowances are made in using this string of tubing for drilling purposes: (1) More drill collars are used to keep the string in tension, and (2) care is taken in making a connection that the tubing is not bent in the slips. The remaining operating conditions are identical with those under which the two strings of 2⅞-in. OD, 10.4 lb-per-ft drill pipe are used.

As seen in this summary, the circulating rates are very low; however, the annular velocities in all cases have been sufficient to keep the hole adequately cleaned. While larger size tubing (3½-in. OD) might improve the hydraulics for drilling 6⅛-in. holes, the additional weight would tend to limit the well depths which could be drilled with the slim hole rigs. Jet velocities are maintained at sufficiently high values to assure rapid removal of cuttings, and even in extreme cases the velocities are still above 165 ft per sec.

A typical bit record is shown in Table 2.

Discussion

The advantages derived from the use of tubing in this specialized case may be summarized as follows:

Initial cost. Using Shreveport, Louisiana, as a base point, 2⅞-in. OD, 6.5 lb-per-ft, N-80 tubing costs approximately $0.90 per ft less than 2⅞-in. OD, 10.4 lb-per-ft, grade E drill pipe. This $0.90 per ft represents a saving of more than 45 percent. To offset the initial cost advantage alone, the drill pipe must drill approximately 80 percent more hole than the tubing before the cost per ft of drilled hole becomes equal.

Weight. The weight reduction has a two-fold advantage: Faster trips and greater depth capacity using the same hoisting equipment and a small but significant reduction in moving costs per well which can become a substantial item over the lift of the string. The drill pipe weighs 9.97 lb per ft while the tubing weighs 6.16 lb per ft, making a difference of 3.81 lb per ft, or a reduction in weight of 38 percent.

Hydraulics. With an ID of 2.441 in. for 2⅞-in. tubing as compared to 2.125 in. for 2⅞-in. drill pipe, a very substantial reduction in pressure loss through the drillstem is realized. For circulation rates between 100 and 200 gal per min, the reduction exceeds 40 percent.

As of February 10, 1958, Woolf & Magee, Inc. has drilled a total of 1,048,508 ft of slim hole which includes the 275,240 ft of hole drilled with the tubing string. With the excellent service received, the company feels the use of lightweight drill pipe has proved its merits in this particular drilling application. ★ ★ ★

J. W. Arnold *was graduated from Southern Methodist University in 1952 with a bachelor of science degree in mechanical engineering. He has been employed with Woolf & Magee, Inc. since that time. In addition to his memberships in the American Institute of Mining and Metallurgical Engineers and the American Petroleum Institute, he is a member of the board of directors of the American Association of Oilwell Drilling Contractors. He is presently chairman of the slim hole sub-committee of the rotary drilling committee of AAODC.*

TABLE 2. Typical Bit Performance Record Drilling with 2⅞-In. Tubing.
Well: Clifford No. 1, Section 56, T6N, R2W, Adams County, Mississippi.
Bits: Three-cone jet roller bits.

Run No.	Bit Size in.	Jet Size in.	Depth Out ft	Feet Drilled ft	Hours Drilled hr	Weight on bit 1000 lb	Rotary speed rpm	Pump Pressure psi	Mud Weight lb/gal	Mud Viscosity sec	Bit condition
1	12¼	½	580	580	6	4	190	400			
2	5⅝	5/16	3404	2824	32	2 to 10	180	1000	9.0	31	Dull
3	5⅝	5/16	4963	1559	24	6 to 10	160	1000	9.5	33	Dull
4	5⅝	5/16	5596	633	16	10	150	1050	9.6	35	Dull
5	5⅝	5/16	6330	734	17	10	140	1150	9.5	36	Dull
6	5⅝	5/16	6515	185	6	10	140	1150	9.5	35	Medium Dull
7	5⅝	5/16	6800	285	8	10	140	1150	9.6	38	Medium Dull

SLICK NEW UNIT

WIRELINE FOR OFFSHORE WELLS

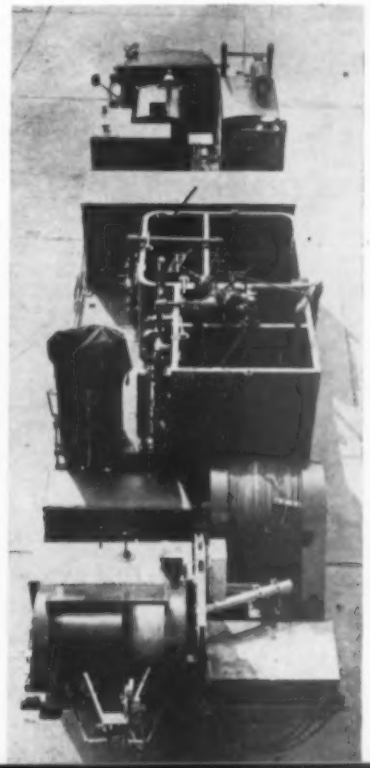
A slick, new wireline workover unit that can be handled by offshore gear as easily as a box of crackers has been developed and tested by Lane-Wells in recent months. The unit is specifically designed for barge and platform work but can also be loaded handily on a float and hauled to land jobs on occasion.

From start to last, the new unit is a one-shotter. In addition to the wireline hoisting equipment, it has equipment for mixing cement, for logging and for perforating. Fifty sacks of cement can be stored in the unit.

The unit breaks down for easy loading. All sections can be lifted in loads not exceeding 6000 lb. Shown here the unit is working in the marshes off Weeks Island plugging back, squeeze cementing and reperforating at higher intervals on one of Shell Oil Company's deep wells.

Setting gin pole for wireline workover of a deep well off Weeks Island. As rigged up, the unit has three reels . . . one with 13,000 ft of 1/4-in. work line, a reel of .092-in. piano wire and one with a 5/16-in. conductor cable.

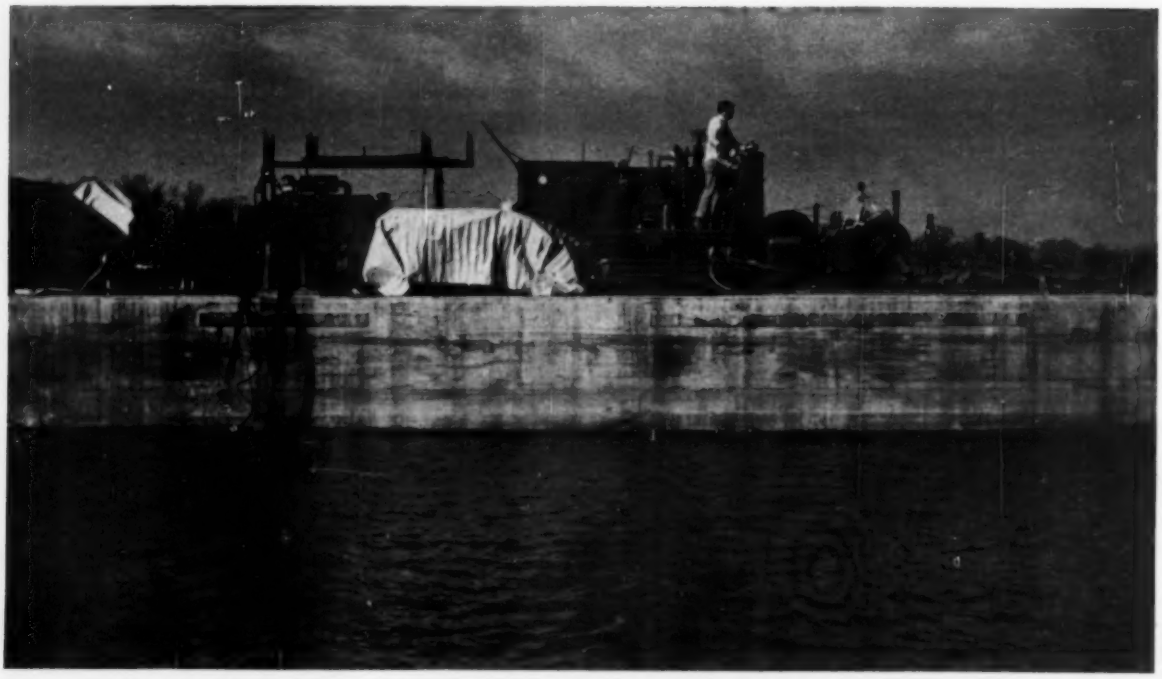
The unit as it left the shop. In the upper part of the picture are the two engines which operate the unit. The larger is a 150-hp engine with torque converter which operates pumps and hoist. The smaller 70-hp engine operates a hydraulic-driven pump. Behind it is a 115 gal fuel tank. Next is the hydraulic oil reservoir which is necessary for operations of this rig. Pumps and tanks are at center of the picture; at the bottom are the three reels with controls.



The unit in operation. Conductor cable reel is at the right of the driller. At the extreme right is a portable work bench used to maintain tools in offshore operations.

Pumper's console overlooks gages. Pumper faces the console with an unrestricted view of his gages, controls and wireline reels—and the well being worked over.

$15,000 worth of wireline workover tools go into the unit. Here at this portable electric bench, crewmen work tools over when necessary for operations.



Profile view shows its small compactness. Under the tarpaulin are extra sacks of cement used in this particular job.

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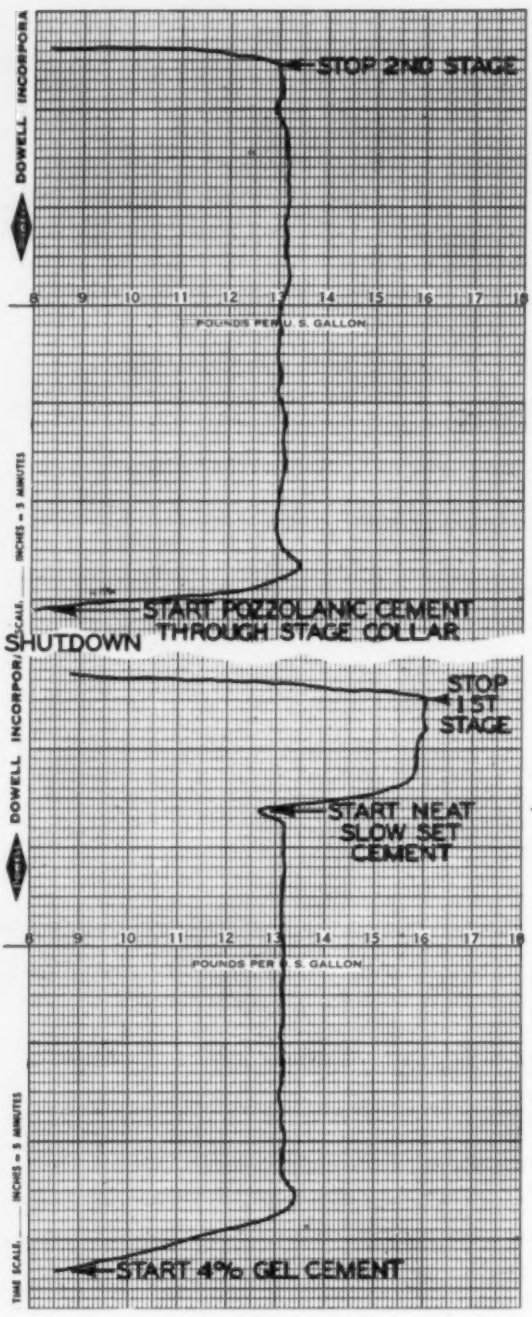

FIG. 1. **Strip chart,** recorded by the densitometer, of a two-stage treatment. First stage consisted of four percent gel and portland cement filler. This was followed by neat cement around the shoe joint. The second stage, applied later through a stage collar above the first stage, was for fill-up purposes and consisted of a 50/50 pozzolan cement mix. Note the adjustments made in slurry weight made without shutting down.

A new oil field tool . . .

GAMMA RAY DENSITY METER IMPROVES OIL WELL CEMENTING

Continuous recording of slurry density in over 800 Gulf Coast wells affords better control of blending operation and assures more uniform cement weights in critical applications

J. P. Moran **D. G. Hartweg**

Dowell Incorporated
Tulsa, Oklahoma

AS AN AID to density control of cement slurries in oil field cementing operations, a sensitive continuous density recording instrument has been developed and is being used extensively in the Texas Gulf Coast area. The gage, called a densitometer, indicates changes of slurry weight ranging from 8 to 18 lb per gal with an accuracy of plus or minus 0.1 lb per gal. The instrument employs a directional gamma ray source and detector to measure the slurry density. Gamma ray transmission through the cement is calibrated in pounds per gallon readings and this information is continuously recorded.

Because the density of the slurry is recorded almost instantaneously, and is visible to the cementing engineer, the characteristics of the slurry being pumped down-hole may be easily and quickly controlled and proportioning adjustments made to meet the most stringent and varying specifications.

An added advantage afforded by the densitometer is the large-scale recording, which gives the operator a permanent document of the cement job, a valuable guide if later remedial work-over jobs are required.

The densitometer is simple to operate in the field and does not require bulky

This article is based on "Continuous Density Recordings During Cementing Operations," presented at the Spring Meeting of the Southern District, API, Division of Production, in Houston, Texas, February 26-28, 1958.

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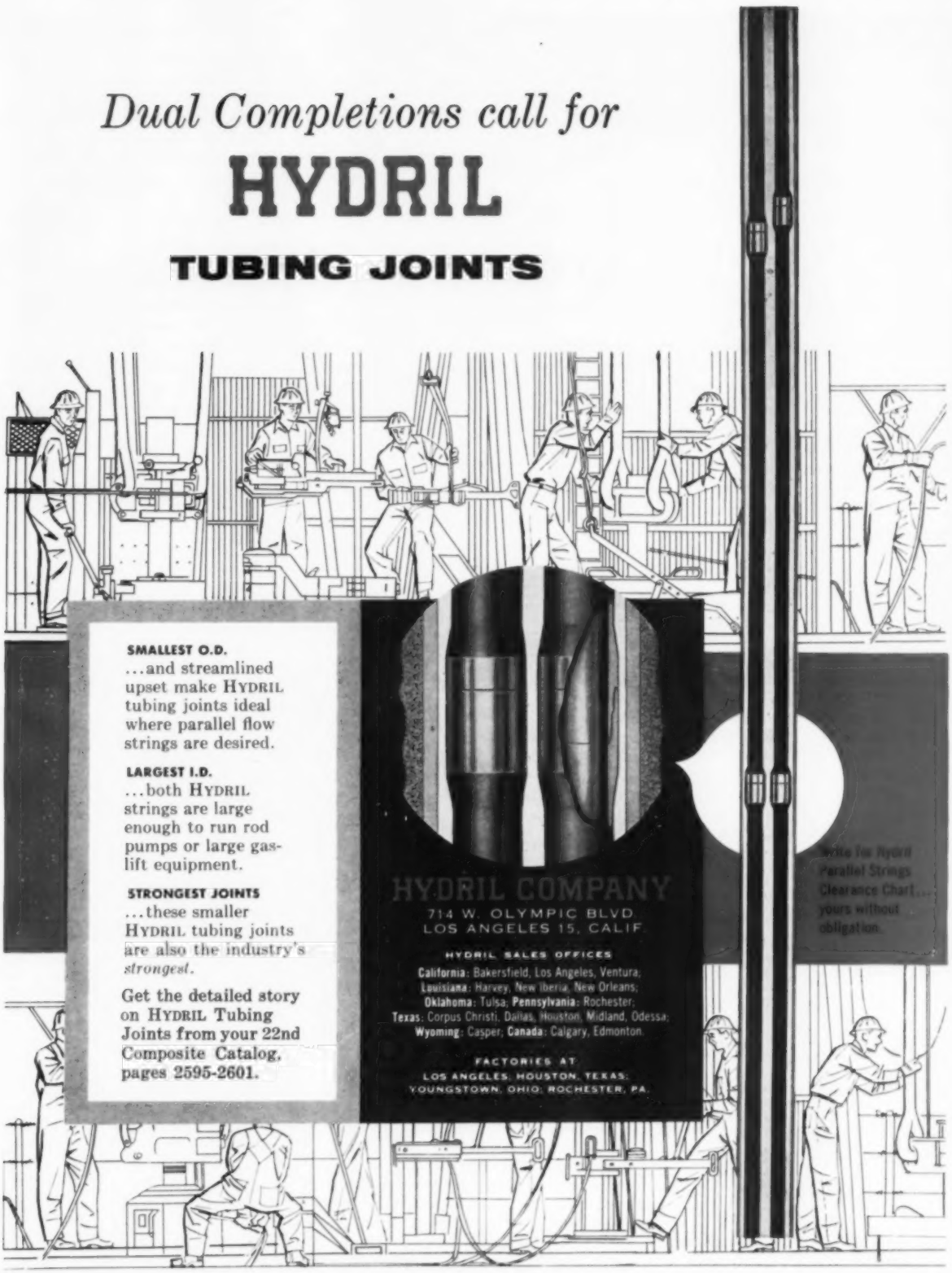

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apparatus or extensive wiring. Density measurements are taken from outside the pipe, eliminating the time and trouble of taking and testing spot samples. Also, by eliminating the sampling step, the time lapse between density checks is completely eliminated. Readings are continuous, and it is not necessary to shut down any pumps or interrupt the flow of slurry into the well. The equipment is rugged and dependable and does not require recalibration during the cementing job.

Value of Better Density Control

The success of oil field cementing operations, whether for completion or remedial purposes, is a vital factor in determining the well's future productive life and the eventual return on the well owner's investment. Because the cement:water ratio (as indicated by the slurry density) largely influences the physical properties of both the slurry and the final set cement, control of slurry density during cementing operations becomes extremely important.

By adding water to the slurry, the viscosity is lowered. This, of course, makes the slurry easier to pump and reduces friction losses in the well. Too much water, however, has several harmful effects. These include:

1. Cement thickening and setting times are lengthened;
2. Pockets of water often separate out of the slurry behind the pipe, resulting in voids in the set cement;
3. Ultimate strength of the set cement is lessened.

Too little water can also have detrimental effects on the slurry. This results in:

1. Difficulties in proper placement;
2. Plug flow;
3. High pump pressure requirements;
4. Channeling;
5. Danger of "lock-up" in highly porous zones before proper placement is effected;
6. Cement brittleness, that permits shattering while perforating.

Aside from these extremes, it is undesirable to have large variations in slurry density, even within limits. Such variations cause considerable nonuniformity in thickening and setting times, making it difficult to predict the optimum waiting period before perforating operations.

With the advent of deeper and deeper wells requiring specialized cement formulations with critical solid: water ratios, it becomes increasingly important that slurry density be closely controlled. If the cement job is to be successful and the set cement is to have optimum strength and sealing characteristics, proper slurry density is important to insure proper initial viscosity, pumpability time, and strength after a predetermined WOC time. Such specialized cements must be mixed and applied properly, or expensive workover operations may be required later.

Densitometer Completes Slurry Control

The slurry densitometer, mounted on the 5-in. slurry flow line on the cement blending truck, permits continuous measurement of the exact density of the slurry, with an accuracy of 0.1 lb per gal. The cementing engineer maintains a constant check on the density of the slurry being pumped into the well, and can immediately adjust any variation in cement:water ratio. As a result, slurry density is more closely controlled and density variations are avoided. This method is naturally more exact than controlling the slurry only by periodic spot sampling and adjusting proportioning controls.

Often well conditions indicate that the hydrostatic column of cement slurry may force cement into a previous lost circulation zone. Sometimes, it is desirable to spot batches of weak cement over sections where it is deemed advisable to prevent shattering during later perforating operations. Using densitometer readings as a guide, slurry density can be immediately altered from one predetermined value to another, and the correct cement:water ratio immediately adjusted to provide a sharp break from one density to another.

Many operators like to tail-in a long

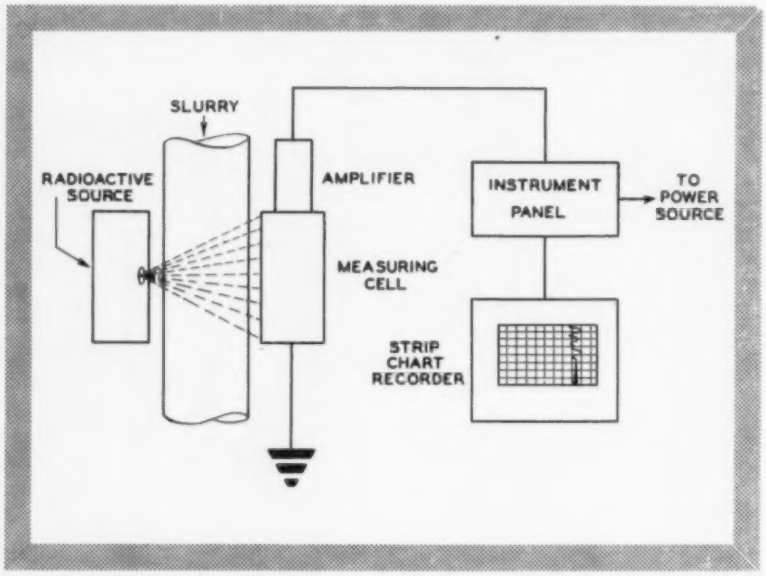
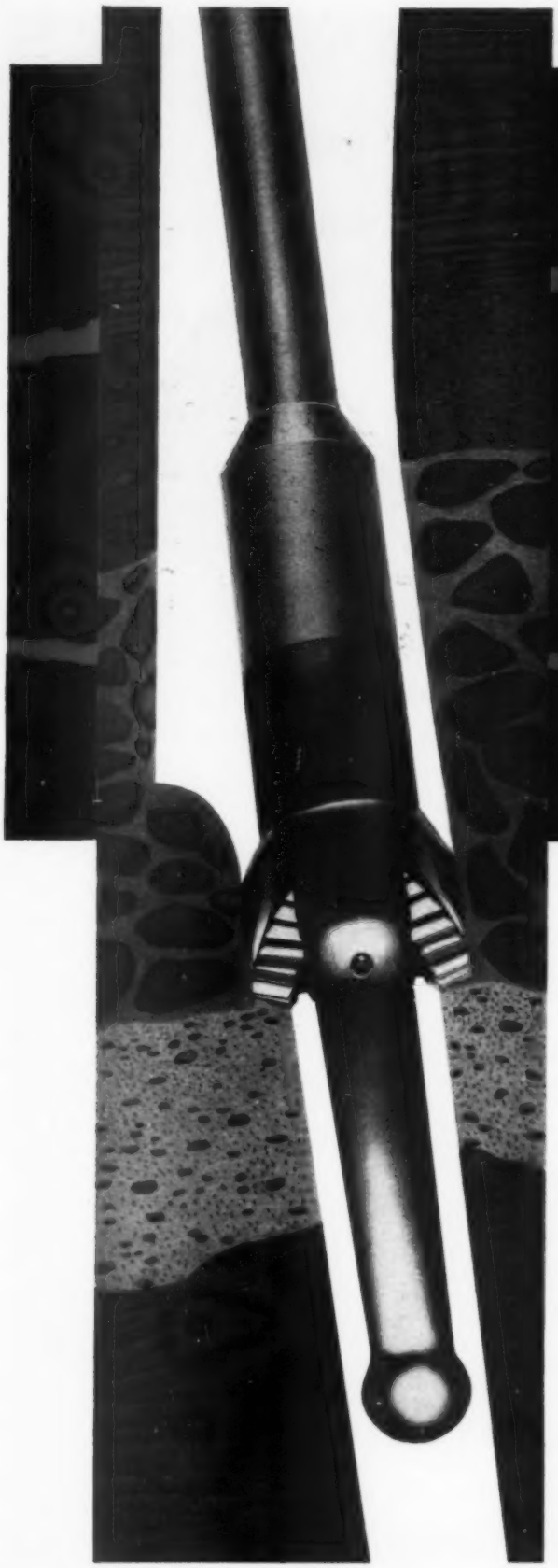


FIG. 2. **Block diagram** showing densitometer and automatic recorder hook-up. Gamma rays are shown passing from the source through the pipe. Part of the radiation is absorbed by the slurry in the pipe. The remainder is measured by the detector cell, converted to electrical energy and passed to the panel, where it is recorded on the strip chart.

Better Mixing Equipment

Cement slurries are mixed at the well site and applied to the well using mobile, high power blending and pumping equipment. Different designs have been developed to provide maximum application ease and slurry uniformity. This equipment brings "perfect" blending one step nearer. Periodic sampling or adjustments made in proportioning controls, however, were still necessary and dependent solely on the operator's experience.



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LONG BEACH DENVER HOUSTON

EASTMAN INTERNATIONAL COMPANY
Exclusive Export Agents
P. O. BOX 1500 DENVER, COLORADO, U.S.A.

"You may save a costly, unnecessary blow-out by eliminating defective joints before running tubing in high-pressure wells..."

. . . and the best way is to run an Otis "Surface" caliper survey to determine any loss in wall thickness . . . in either new or used tubing."

Q. John, you said new tubing; isn't the wall thickness in new pipe full-gauge?
A. By no means. Many times, we have made Otis tubing corrosion surveys and found serious internal defects . . . not due to corrosion, but rather to "original mill deviations."

Q. Is that bad?
A. It's bad if you run one of those weak joints in a high-pressure well. But you can avoid that by calipering the pipe on the rack — *before* it is run. And this can be done on the location, or in the pipe yard . . . and also to grade used tubing.

Q. What is usually done after the pipe is graded?
A. Tubing can be run into high-pressure wells if it is in good shape. Other grades can be used in pumping wells, or for line pipe, for structural purposes, or junked — all according to its grade.

Q. Why is the Otis service superior?
A. For one thing, we have a permanent, strip-chart to document our grading of each joint. There is no "visual" estimation nor guesswork; the Otis Caliper measures the actual, internal condition of the pipe. Too, we have calipered more pipe — millions of feet in fact — than any other service company.

Q. How does the instrument work?
A. As the caliper is drawn through the joint, the feelers contact the inside wall of the pipe. As a corrosion pit is encountered, direct action of any one of the feelers causes an electrical signal to be transmitted to the strip-chart recorder. Thus the internal condition is recorded immediately, and we can color-code and classify each joint accordingly.

Q. What if the inside of the pipe is heavily scaled?
A. Well, although the feelers will probe through all but the very hardest deposits, we can also clean the tubing, using an air motor and a wire brush in a combination operation—cleaning in one direction, and calipering on the return trip.

Q. Does this cleaning time slow you down?
A. Not too much; it usually takes from 1 to 1½ minutes to clean, and 30 seconds to caliper. Thus we can average from 20 to 30 joints per hour.

Q. Is this "Surface" Caliper service available now?
A. Indeed it is — from any of our Branches Throughout the Oil Country. We can do a survey for you today, if you want us to.

OTIS Engineering
CORPORATION
BRANCHES THROUGHOUT THE OIL COUNTRY

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

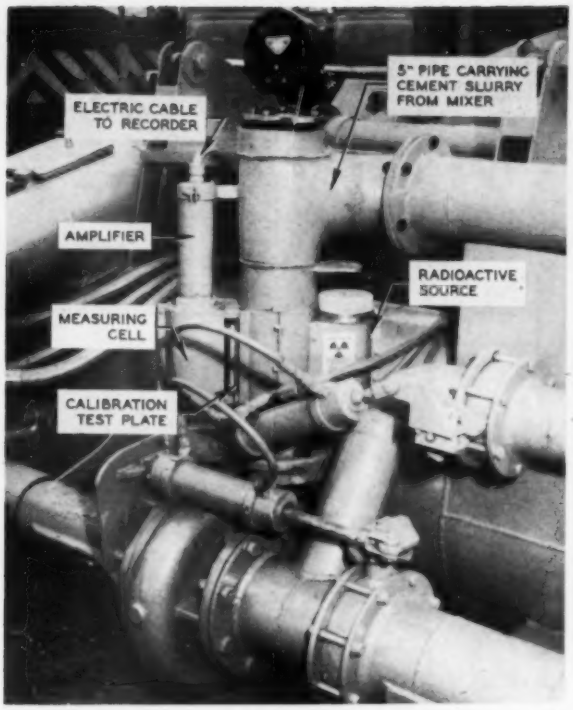


FIG. 3. **Densitometer unit** is installed on the pipe carrying the cement slurry just prior to being pumped down the well. The lightweight unit is bolted around the 5-in. pipe.

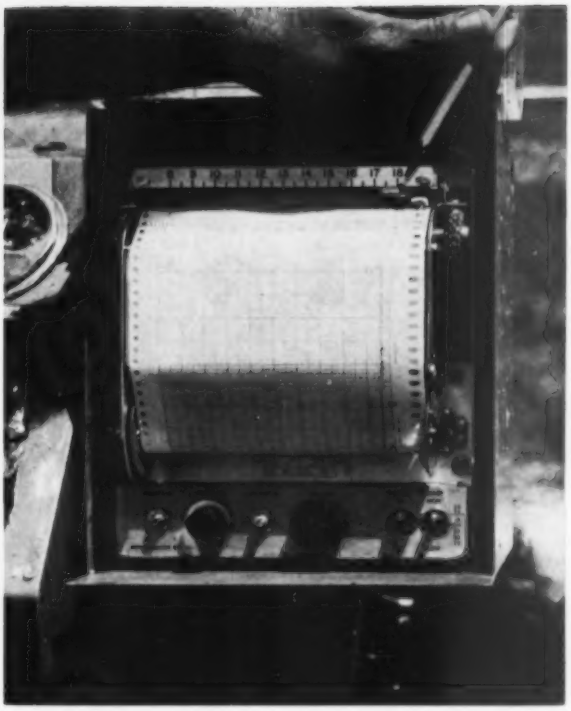


FIG. 4. **Automatic recorder,** showing the strip chart calibrated to record slurry densities from 8 to 18 lb per gal. The strip chart can be set to run at two different speeds, depending on the sensitivity of the measurement required.

string job with neat cement to provide dense cement with high compressive strength around the shoe. The bulk of the cement around the casing can be a low-cost, weaker material which functions merely to fill behind the pipe. Many jobs have used this combination of materials. Using the densitometer control, a switch from a 13-lb to a 15-lb slurry is made quickly and accurately. (Fig. 1.)

The continuous record made during the entire cementing operation provides a permanent record for the well file, indicating (when correlated with depths) the type of cement behind any particular section of casing. It also assures the producer that the cement job he received was exactly as desired. Such a permanent record acts as a valuable guide in case later remedial workovers are required.

Instrument Components

The densitometer consists essentially of three elements, a radioactive source, a radiation detector, and an automatic recorder (Fig. 2). Briefly, gamma rays from the radioactive source pass through the cement slurry stream. Part of this radiation is absorbed by the slurry. The unabsorbed portion is measured by a gamma ray detection cell. The amount of radioactive energy absorbed by the slurry is proportional to slurry density. The unabsorbed radioactive energy is converted to electrical energy in the measuring cell. The change of gamma ray intensity is converted into a change of electrical current, the magnitude of which is a measurement of the percent of solids of the slurry. The electrical current is then transferred to the amplifier and through an electrical cable to the recorder and onto the strip chart. These readings are continuously recorded on the chart and calibrated to read directly in terms of slurry weight in pounds per gallon versus time. (Fig. 3.) The radioactive source is a suitably shielded capsule of Cesium-137, approximately 50 millicuries in amount.

Prior to the treatment, the shield is removed from in front of the radioactive source and the calibration checked by means of standardized, lead absorption plates. Any minor variation is easily corrected by adjustment of the zero and linearity controls. Once the calibration has been checked, the instrument is ready to function.

Readings are continuously recorded on a strip chart horizontally calibrated to give a direct reading in pounds per gallon. This chart records densities from 8 to 18 lb per gal, and has 100 divisions, each equivalent to 0.1 lb per gal. This range includes all commonly used cement formulations (Fig. 4). The chart can be driven at two speeds, depending upon the sensitivity of measurement desired. It is divided vertically, 10 divisions to an inch and can be driven at the rate of either one or two inches per five minutes. Density readings are accurate to within 0.1 lb per gal. The readings on the chart are steady and free from fluctuation caused by random emission characteristics of the radioactive source. This eliminates errors in reading or "mental averaging" of a fluctuating reading.

Safety Factor

This apparatus is completely safe for operating personnel in the vicinity, if ordinary caution is observed. When not in use, the radiation source is completely surrounded by lead shielding. When in use, the path of the gamma rays is restricted so that only a negligible amount of radioactivity can escape. Normally, the radiation level within a 12-in. radius from the source is less than four milliroentgens per hour. For maximum safety, however, all personnel are cautioned to stay at least three feet away from the radioactive source while it is in operation. The slurry does not become radioactive by the absorption of gamma rays. ★ ★ ★

keep cement where you want it!

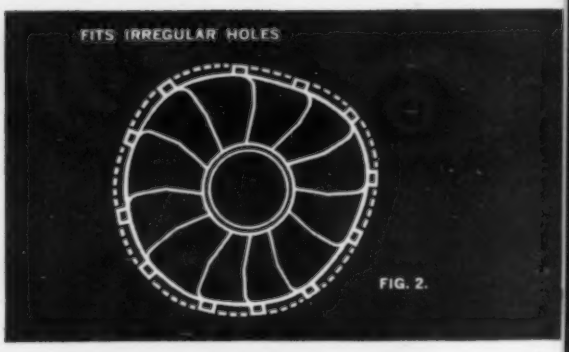


FIG. 2.

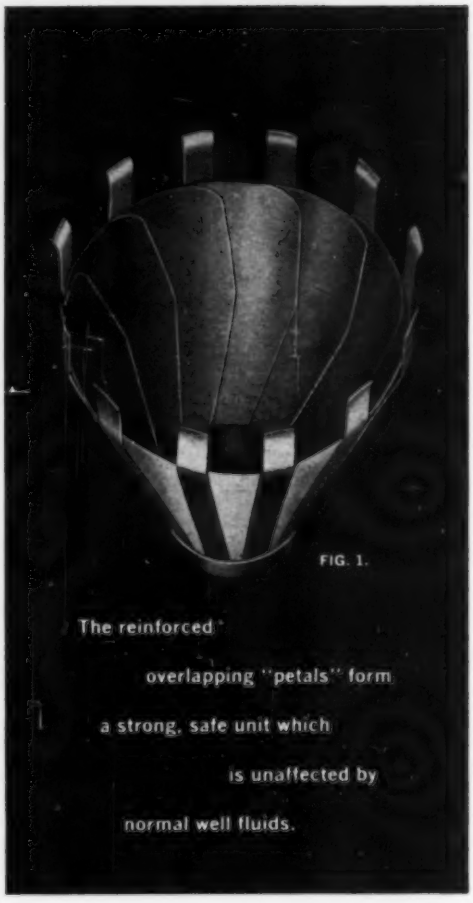


FIG. 1.

For Problem Cementing, where a lower permeable (or weak) zone must be protected from the cement slurry, or from sloughings and cavings, the Baker METAL PETAL Basket is safe and successful.

A number of "petals" made of flexible sheet steel are mounted on reinforcing spring-steel ribs which in turn are mounted on a ring to form the Basket. This all-metal construction provides unusual strength; there is little likelihood of damage to the unit while running in the well.

Safe, Automatic Operation—While running in the well, upward pressure of the fluid (see Fig. 5) tends to close the petals, thus providing fluid passageway between the Basket and the wall of the hole, without distortion or damage to the Basket. As soon as the casing comes to rest, upward pressure by the fluid is relieved and the petals expand to contact the wall of the hole (see Fig. 6). Any tendency of fluid to move downward then presses the flexible petals more firmly against the entire circumference of the hole. Solids which are strained from the fluid serve to build a bridge inside the Basket, which is thus converted into a one-way annular packer of great strength and effectiveness (see Fig. 7).

Fits Large or Irregular Holes—The "Metal Petals" not only expand to contact the entire circumference of large-diameter holes (see Fig. 4) but also pack-off in holes of irregular shape as shown in Fig. 2. The independent action of the individually mounted overlapping petals permits successful use of Baker Metal Petal Baskets in casing programs with minimum clearances (see Fig. 3).

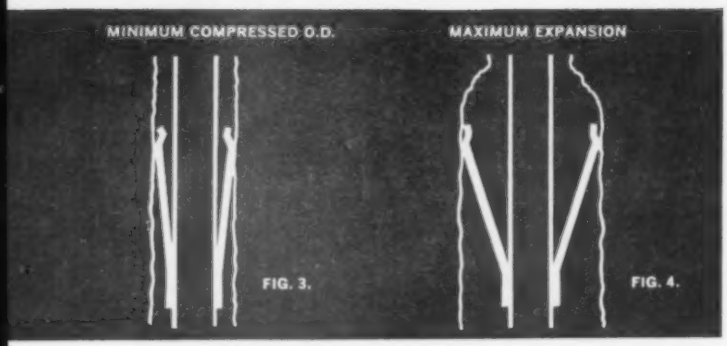
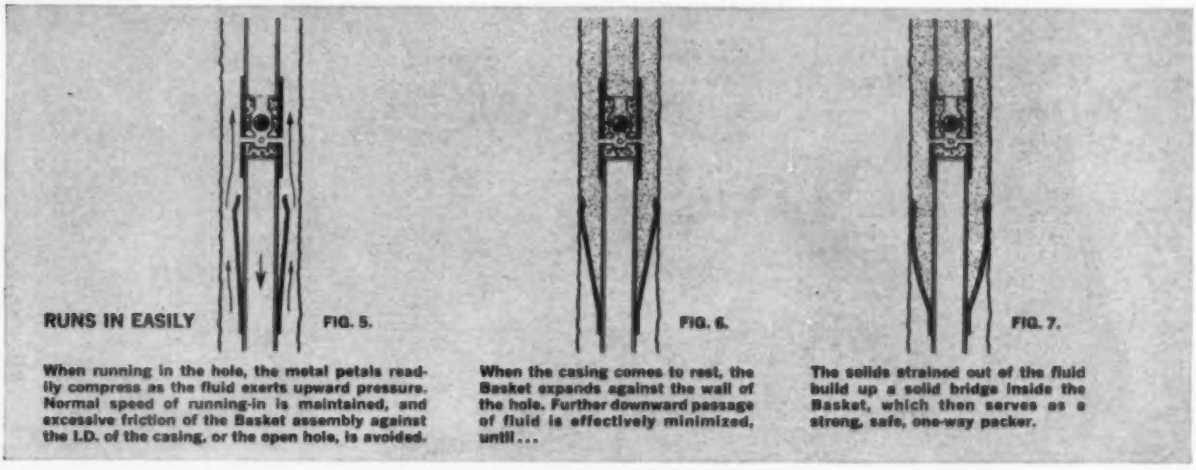


FIG. 2.
FITS IRREGULAR HOLES – The Basket expands to contact the entire circumference of irregularly shaped holes.

FIG. 3.
MINIMUM COMPRESSED O.D. – Less than ½" greater than coupling O.D. – providing ample running-in clearance.

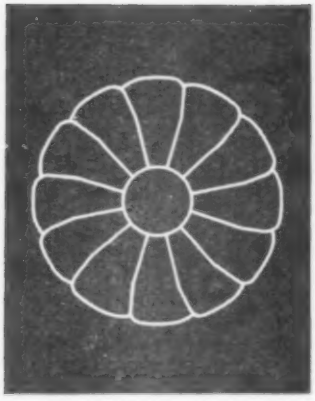
FIG. 4.
MAXIMUM EXPANSION – The Basket expands to more than twice the diameter of the casing on which it is run in sizes 5½" and larger.



When running in the hole, the metal petals readily compress as the fluid exerts upward pressure. Normal speed of running-in is maintained, and excessive friction of the Basket assembly against the I.D. of the casing, or the open hole, is avoided.

When the casing comes to rest, the Basket expands against the wall of the hole. Further downward passage of fluid is effectively minimized, until . . .

The solids strained out of the fluid build up a solid bridge inside the Basket, which then serves as a strong, safe, one-way packer.



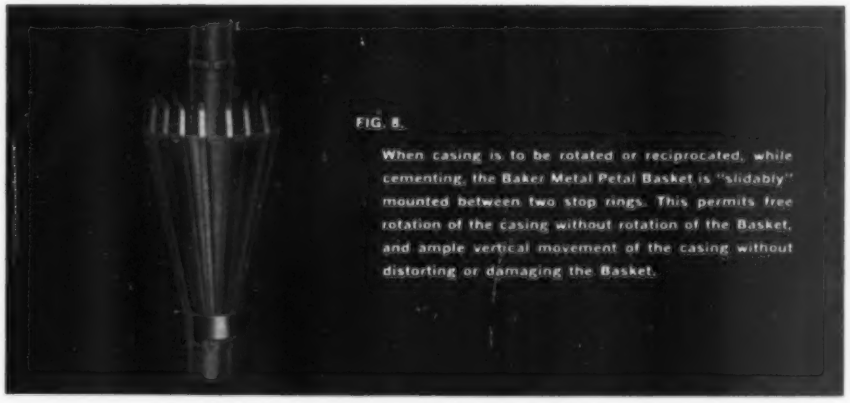


FIG. 8.

When casing is to be rotated or reciprocated, while cementing, the Baker Metal Petal Basket is "slidably" mounted between two stop rings. This permits free rotation of the casing without rotation of the Basket, and ample vertical movement of the casing without distorting or damaging the Basket.

Mountings Meet All Needs—The Baker Metal Petal Basket is furnished as a separate unit for installation to meet any requirement. Generally it is *slidably* mounted by spacing two split stop rings some distance apart to allow free travel of the Basket and free rotation of the casing. Baskets can be furnished affixed to either a *plain* or a *perforated* nipple to meet cementing requirements.

Baker Metal Petal Baskets are used extensively in combination with Baker Stage Collars to retain and support the cement slurry for the second stage. Baker Casing Centralizers are normally used above and below such combinations to provide uniform annular clearance.

Any Baker representative will give specific recommendations for the use of Baker Metal Petal Baskets; or see the BAKER (or Composite) Catalog.

BAKER

METAL PETAL BASKET

PRODUCT NO. 343

BAKER OIL TOOLS, INC.

HOUSTON • LOS ANGELES • NEW YORK

There is structure!

DELAWARE BASIN: WHAT TRAPS ITS OIL?

by C. F. Dodge
Associate Professor of Geology
Arlington State College, Arlington, Texas

Deeper drilling, reanalysis of logs and cores hold the key to understanding oil-bearing sandstones of the Delaware Basin — another geological enigma of West Texas and New Mexico

What traps Delaware sandstone oil? This has been a puzzling question to the West Texas-New Mexico exploration geologist since the discovery of the Wheat field in Loving County, Texas, in 1925.

The Delaware Basin covers some 10,000 sq miles of West Texas and New Mexico. There have been several excellent oil fields developed in the upper section of the Bell Canyon member of the Delaware Mountain group – the so-called Delaware sandstone. The Wheat field was the first discovery, followed by Mason, North Mason, Tunstill, Chapman, Quito, and others.

Theories as to how entrapment of Delaware oil occurs vary from the open reservoir hypothesis to porosity development on a terrace. No field on the western shelf of the Delaware Basin exhibits structural closure on the top of the so-called Lamar limestone or on the top of the Delaware sandstone. This fact, along with the apparent variation in porosity development, has led to the various theories of entrapment. It appears that the exploration geologists of the Delaware Basin have not looked quite deep enough at, and into, the Delaware sandstone. For this reason, an important feature may have been missed, with regard to oil entrapment in the Delaware — namely, structure.

Ford Field: A Marker

The Ford (Delaware) field was discovered in 1956 by the Ford Chapman et al No. 1-18 Ramsey, located in Section 18, Block 57, T-1, T. & P. R. R. Co. Survey, Reeves County, Texas. This well potentialed for 267 bbl of oil per day from open hole at 2649 to 2653 ft.

There are 31 wells in the field at this time, with the Continental Oil Company having a total of 19. The remainder are divided between Ford Chapman et al and Hill and Meeker et al.

There Is Structure!

A detailed study of all available well logs and core descriptions of the var-

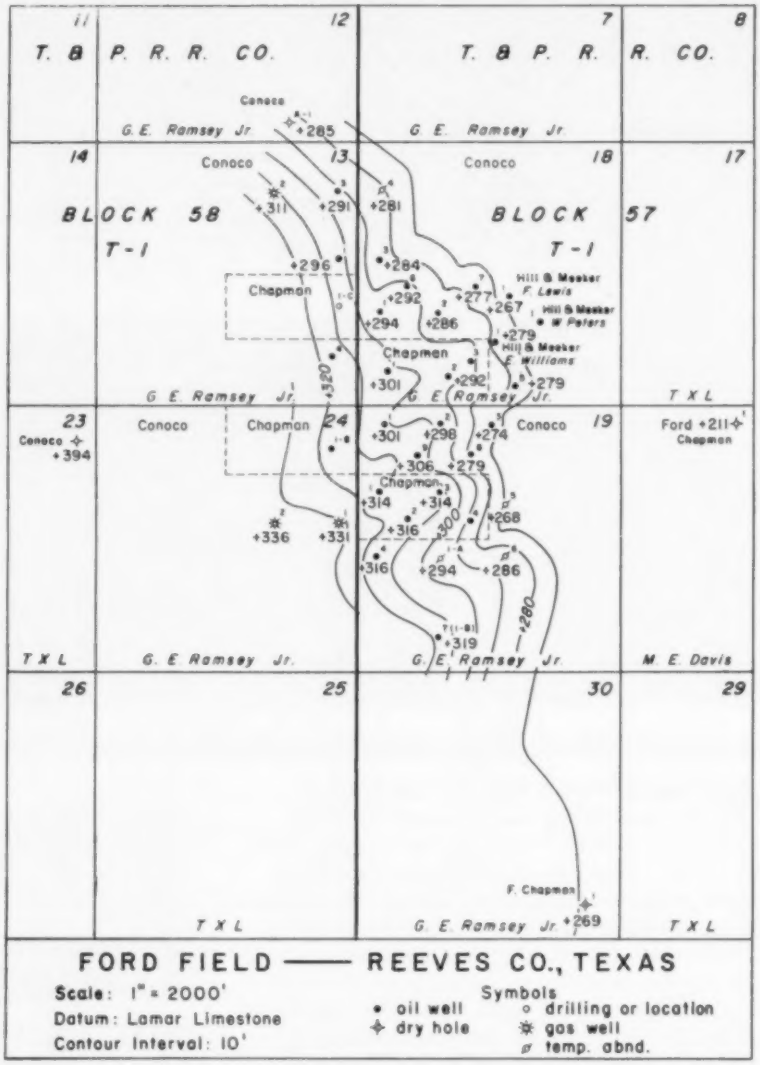
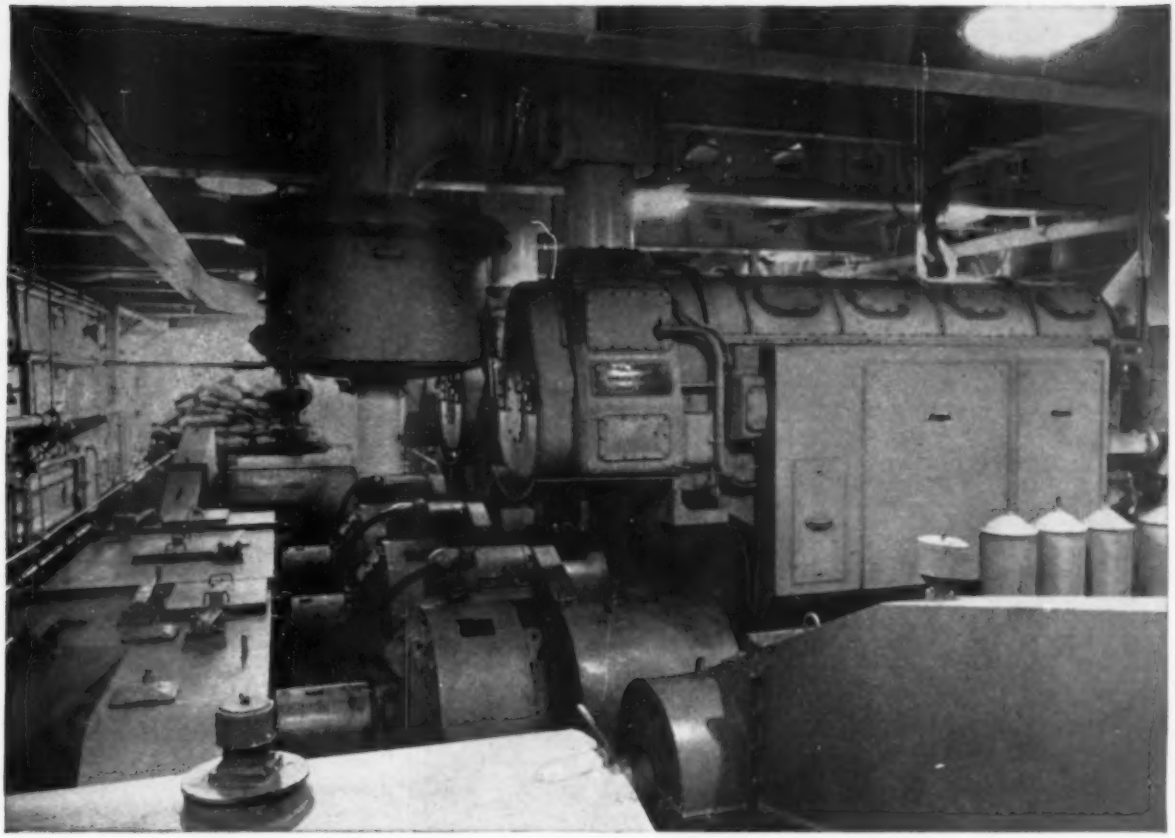


FIG. 1. **Structure contour of Lamar limestone.** The Delaware sandstone would show the same configuration. The Lamar lies approximately 31 ft above the Delaware in the Ford field, Reeves County, Texas. Contour interval is 10 ft.



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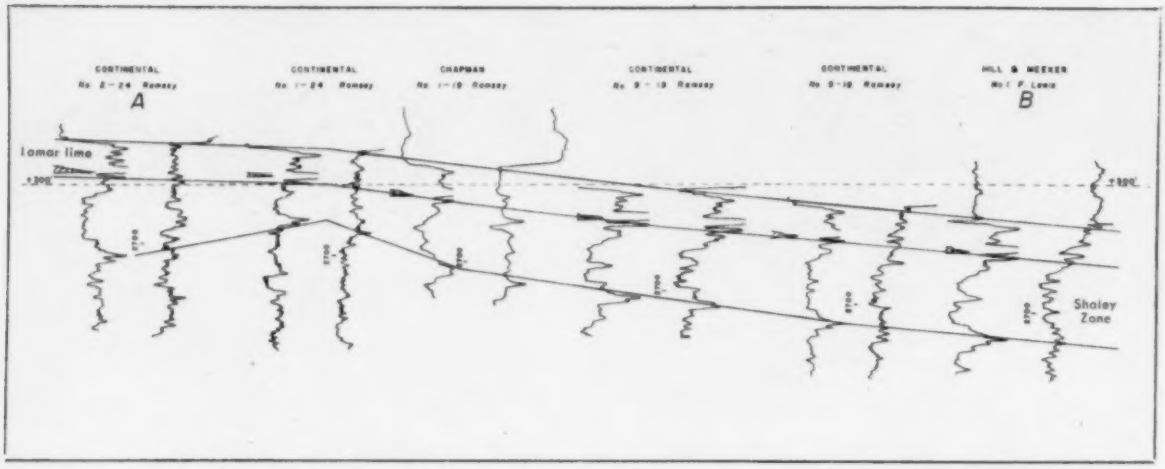

FIG. 2. **East-west cross section** showing structural relationship of the Ford field shaley zone to the Lamar limestone.

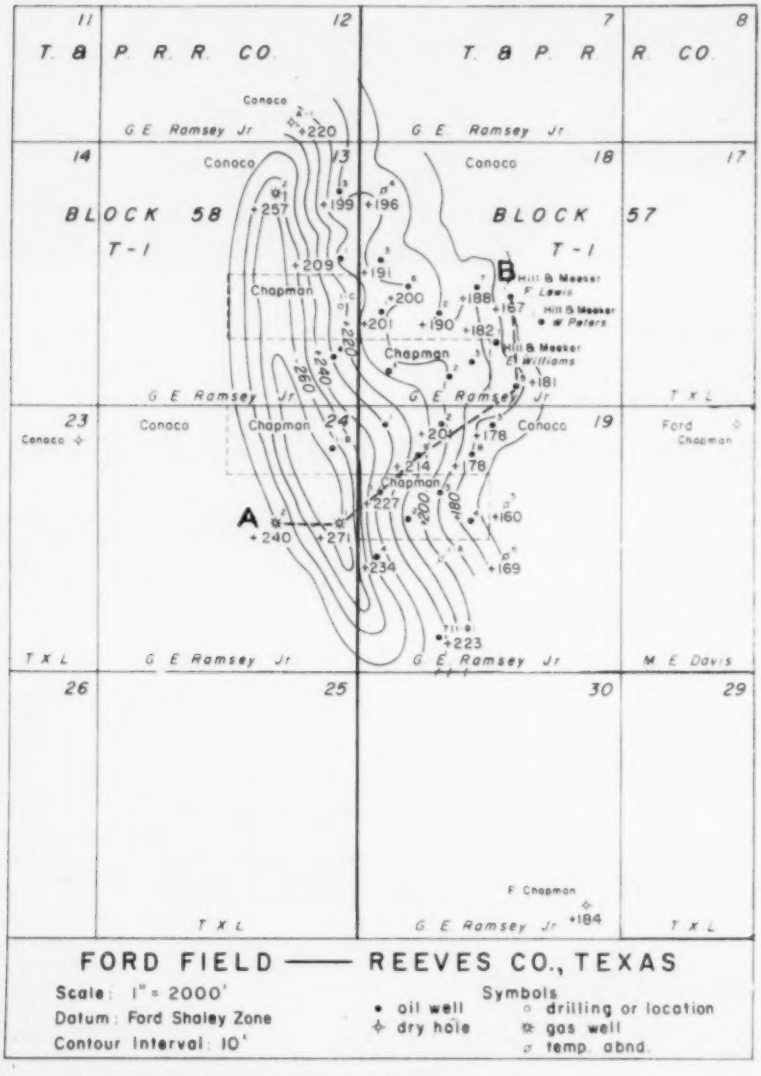

FIG. 3. **Structural contour map** of the Ford field shaley zone.

ious wells in the field has revealed the following:

1. There is no closure on either the top of the Lamar limestone or the Delaware sandstone (Fig. 1).

2. There is a shale bed or shaley zone developed within the Delaware sandstone in all wells in the field area. Of the seven core descriptions on various wells in the field area, all reveal the presence of a shale bed or a shaley zone below the top of the Delaware sandstone. Core descriptions were plotted against gamma ray log characteristics, and the results showed the shale to correlate with the first high gamma ray "kick" below the top of the Delaware sandstone. Careful correlation of all gamma ray-neutron logs in the field area indicated that this shaley zone carries for some distance locally. The east-west cross section, Fig. 2, shows the log character of the Ford field shaley zone.

3. Both a structure contour map on the Ford Field shaley zone and an isopach of the interval from the top of the Lamar limestone to the Ford shaley zone indicate structural relief to exist in the field (Fig. 3 and Fig. 4).

Both the Ford shaley zone contour map and the east-west cross section would appear to indicate structural entrapment of the Delaware sandstone oil in this field. From the above evidence, it is necessary to determine whether the nature of the trap is a result of structural folding or structural drape.

The Lamar limestone, the first continuous rock unit overlying the Ford shaley zone, shows no structural relief over this field. This would appear to minimize the possibility of Middle Permian structural folding.

Pre-Permian Folding

There are several Pre-Permian folds of major proportions in the Delaware Basin. The Toyah (Devonian) field in Reeves County, Texas, and the Bell

keep 'em turning
to the right . . .

with quality engineered

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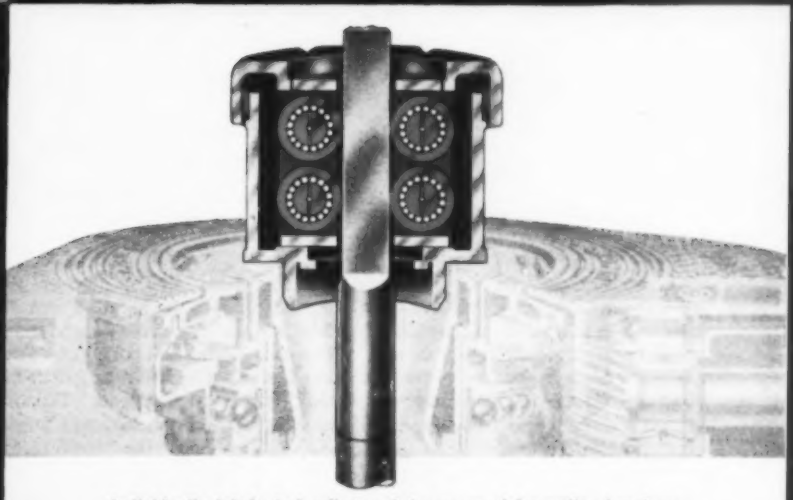
Since the rollers always provide smooth, friction-free feeding, weight indications are accurate; damaging impacts to drill string and other equipment can be avoided.

Superior performance has made Baash-Ross kelly drive bushings preferred in the industry. For additional information write to P. O. Box 1348, Houston 1, Texas, or see the Composite Catalog.



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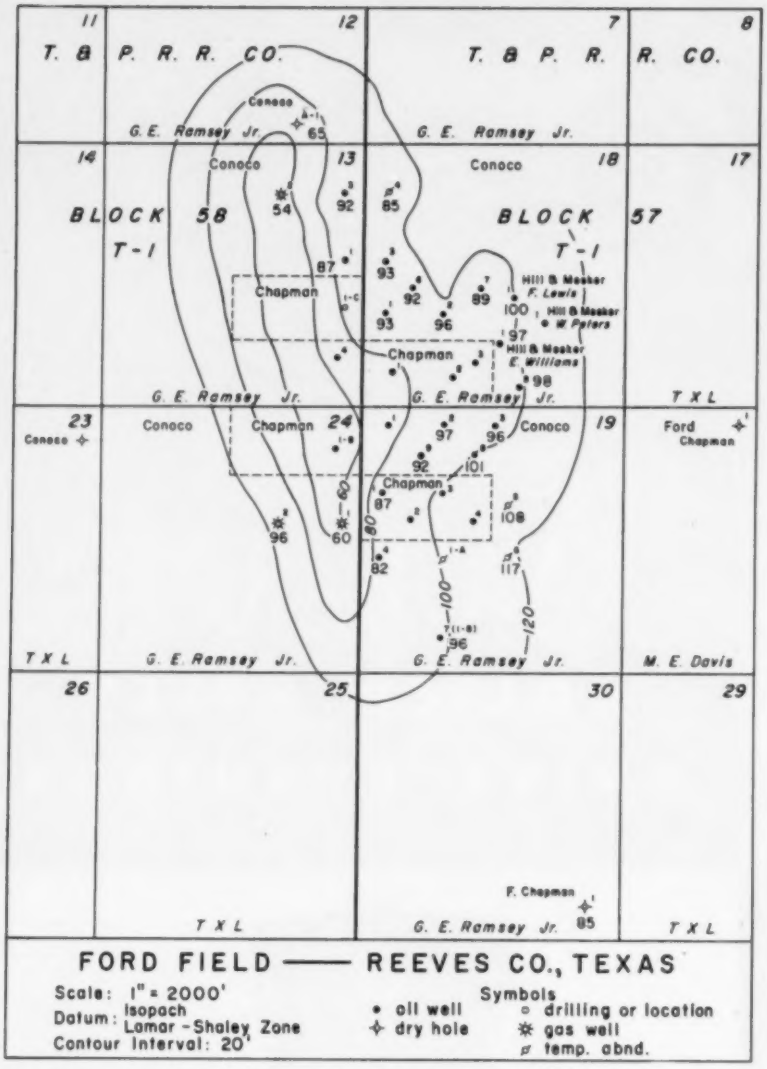

FIG. 4. Isopach of the interval from the top of the Lamar lime to the Ford shaley zone. Contour interval is 20 ft.

Lake (Pennsylvanian and Devonian) field of Lea County, New Mexico, are probably the best known. The probability of other major Pre-Permian folds, even fold trends, similar to those found on the Central Basin Platform and in the Midland Basin appears excellent. It should be kept in mind that probably up into the middle Paleozoic, there was no so-called Central Basin Platform. The whole of West Texas and southeast New Mexico was one great Paleozoic geosyncline. The orogenic forces that formed the prolific anticlinal folds and fold trends in the Pre-Permian rocks of the Central Basin Platform and Midland Basin undoubtedly affected the Delaware Basin Pre-Permian section.

The Yates sandstone is of Guadalupean Permian age. It is present in the stratigraphic section of both the Central Basin Platform and the Midland Basin. This sandstone unit is an excellent mapping horizon, and is used extensively in the subsurface of these areas. As a unit, it will reflect, by structural drape, untruncated Pre-Permian structural folds and reef build up.

In the Midland Basin, the Yates sandstone occurs from 6000 to 8000 ft above Pre-Permian rocks in the stratigraphic section. The relationship of Yates structural relief to Pre-Permian structural relief will vary; however, in almost every case, the Yates will show definite drape over deep seated structure.

Only 50 Wells

There have been less than 50 wells drilled into Pre-Permian rock in the Delaware Basin to date. The depth from the top of the Delaware sandstone to the Pre-Permian section varies from 8000 to 10,000 ft. This depth range is not much greater than that found in the Midland Basin, and it would seem a logical assumption that the Delaware sandstone, or some continuous and/or mappable horizon therein, should reflect deep seated structural folding.

It would appear fortunate that the Ford shaley zone is developed in the stratigraphic section of the Ford (Delaware) field area. The fact that there was oil above and below the shaley zone led to a majority of the wells in the field being drilled through the zone. In no other field in the Delaware Basin has sufficient Delaware sandstone section been penetrated in enough wells to allow close correlation of possible structural marker beds. Most operators set on top of the Delaware sandstone or drill into the pay only a few feet.

Deeper Drilling

Detailed re-analysis of all available electrical surveys and careful re-study of core descriptions will undoubtedly uncover other structural markers within the Delaware sandstone. This, along with deeper penetration into the Delaware sandstone, will go a long way toward solving the age-old question of what traps Delaware sandstone oil. It should also give some very important leads as to the nature of the Pre-Permian folds as reflected by Delaware age structural drape.

Acknowledgment

The author wishes to express his appreciation to the Continental Oil Company for well logs and core descriptions.

★ ★ ★

The Author

Charles F. Dodge *is associate professor of geology at Arlington State College, Arlington, Texas. He holds BS and MS degrees in geology from Southern Methodist University. Dodge first taught at ASC in 1948, then joined Concho Petroleum as field geologist in 1950. In 1952 he became geologist for Intex Oil Company. In 1953 he joined American Trading and Production Corporation as an area geologist in Midland, Texas; in 1955 he became district geologist for the company's West Texas-New Mexico district. In 1957 Dodge rejoined Arlington State to accept his present faculty position.*

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National Rods reach you in factory condition, too, whether you get them from National Supply Store stocks or directly from the mill. National's careful methods for stacking, handling, shipping and field storage have been proved by hundreds of shipments to all parts of the world.

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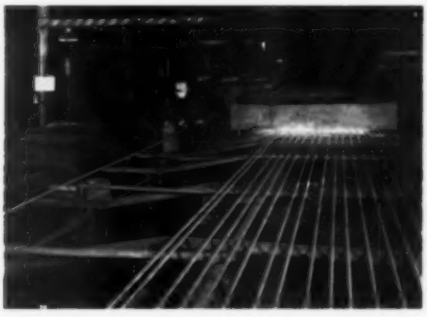
From any standpoint, the choice of a National Sucker Rod string means low-cost sucker rod service. You'll find it worthwhile to review your rod needs with the National Supply field man in your area.



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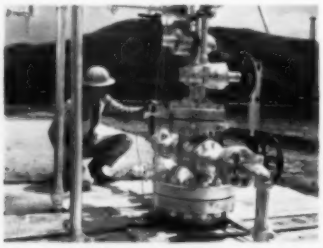

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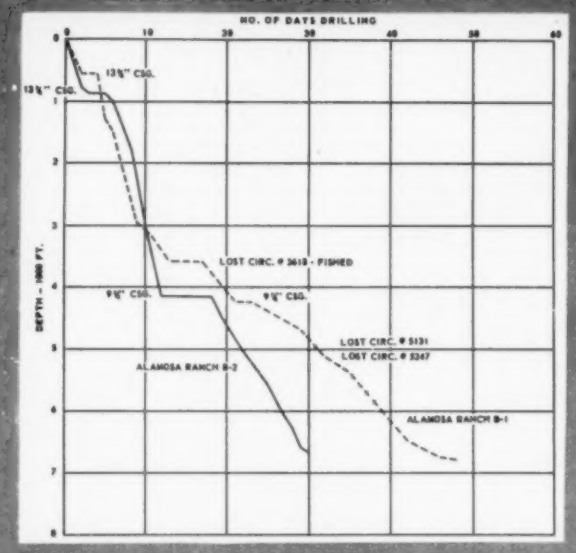


FIG. 1. **Comparison of total drilling days** between air-drilled Alamosa Ranch B-2 and mud-drilled Alamosa Ranch B-1.

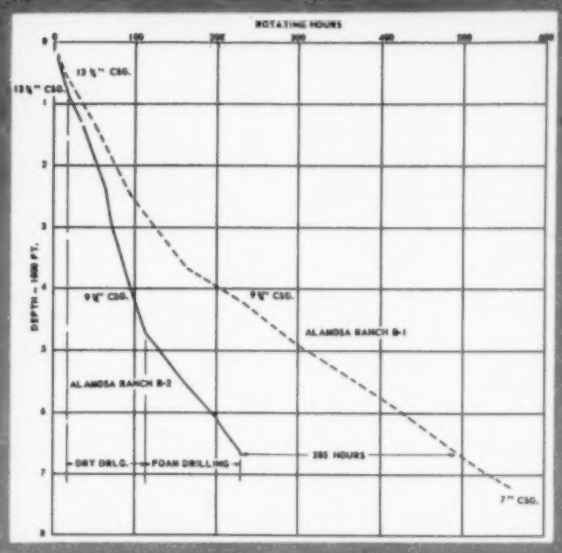


FIG. 2. **Comparison of rotating hours** between air-drilled Alamosa Ranch B-2 and mud-drilled Alamosa Ranch B-1.

In one Texas Panhandle well . . .

P 420.33

AIR DRILLING WITH FOAM COMBATS WATER INFLUX

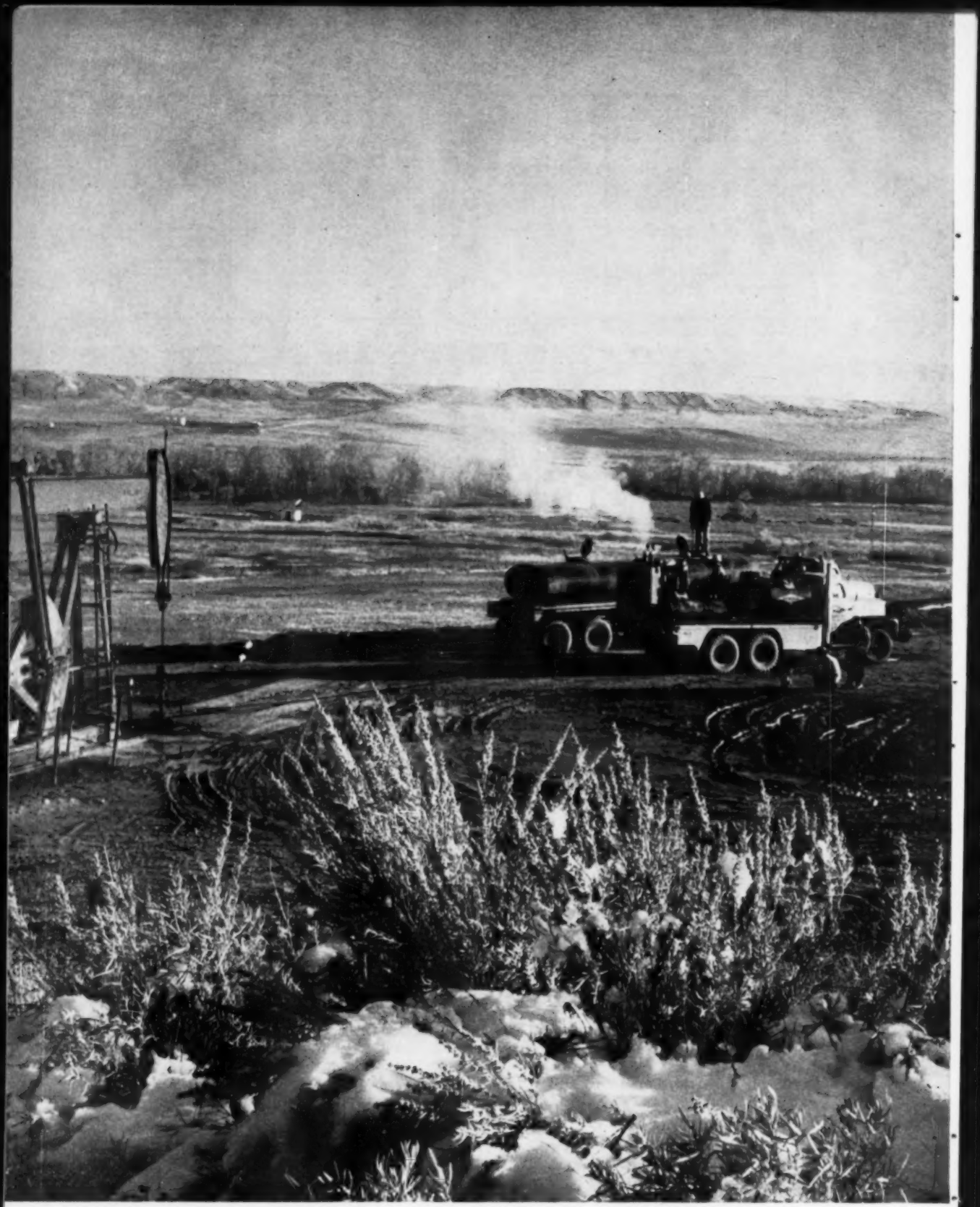
To solve lost circulation problem, nearly 2000 ft of hole drilled successfully with water flows over 50 bbl per hour

R. M. Reed
Shell Oil Company
Oklahoma City, Oklahoma

IN THE Palo Duro Basin of the Texas Panhandle, one well was air-drilled in an attempt to solve the area's major drilling problem . . . lost circulation. In Shell's Alamosa Ranch "B" 2 well, foaming agents were used experimentally to handle water influx when water-bearing formations were encountered. Nearly 2000 ft were drilled successfully while handling water flows of over 50 bbl per hour. Sizable water flows can be handled successfully if the exposed formations do not slough in the presence of water. Penetration rates while foam drilling, although not as fast as drilling with air in a completely dry hole, were still 60 percent faster than with mud. Even with this substantial increase in penetration rates, the high cost of foaming agents and delays caused by the newness of the operation combined to make the cost of this well only slightly less than an offsetting well which was drilled with mud. The use of foaming agents should extend the application of air drilling and permit greater savings to be made in the future.

Based on a paper "Use of Foaming Agents in Air Drilling, Oldham County, Texas," presented at the Spring Meeting of the Mid-Continent District, Division of Production, American Petroleum Institute, Oklahoma City, Oklahoma, April 9 to 11, 1958.

Basis for using air. The potentialities of air drilling have been recognized for a number of years. Until recently, however, its application has been limited to certain interior drilling areas where water-bearing formations offer no problem. Not only are penetration-rate increases often spectacular, but lost circulation ceases to be a problem if air can be utilized as the circulating med-



IN NIOBRARA COUNTY, WYOMING, the acid-oil emulsion used in Acid Petrofrac gives excellent results in the first Leo sand at about 5400 feet. 5000 gallons of this emulsion is generally recommended for pays 50 to 75 feet thick. The treatments usually cost less than $3000. Some have resulted in 100 bopd production. Payout is often less than ten days.

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IN KNOTT COUNTY, KENTUCKY, Stabilized Acid —an exclusive Dowell service—has proved successful in the Big Lime Field, where many wells have actually shown decreased production when treated with other acids. Dowell uses 2000 gallons regular acid, followed by 2000 gallons of acid containing a special stabilizing agent. This relatively low-cost treatment is being accepted as standard in the field.

ium. In many cases alleviation of lost circulation, in itself, can be sufficient justification for air drilling.

The Palo Duro Basin of the Texas Panhandle is an area where lost circulation has proved to be the principal drilling problem. Light-weight 40-percent oil-emulsion muds, batch treating of losses with heavy concentrations of lost-circulation material, and careful rig operating techniques have all been used with only limited success in combating this problem. Severe and recurring lost circulation in this area continues to result in high mud costs and slow drilling progress. As a further attempt to solve these related problems, air was chosen as the circulating medium for the Shell-Alamosa Ranch "B" No. 2 well in Oldham County, Texas. In a mud-drilled offset, Shell-Alamosa Ranch "B" No. 1, serious loss of circulation occurred three times and resulted in one costly fishing job.

Where water-bearing formations are encountered, air drilling is usually abandoned in favor of conventional drilling methods. Damp or weeping zones cause balling-up of cuttings and present the danger of stuck drill pipe. Periodic slugging with water to flush the hole has sometimes been useful in the past to control this condition. Larger flows of formation water have been handled where adequate compressor capacity is available and if exposed formations do not slough in the presence of water. Drilling progress suffers under either condition, however, principally because of time-consuming operational procedures found necessary in handling water influx.

Preliminary studies, based on logs of nearby wells, indicated the probability of encountering sizable water flows in the Alamosa Ranch "B" No. 2 in the Wolfcamp series of Permian age; damp zones were expected at shallower depths. The use of foam offered promise of relieving water-handling problems through increases in lift efficiency and aeration of the circulating system. For this reason experiments in the use of foaming agents were planned and conducted during the air-drilling of this well.

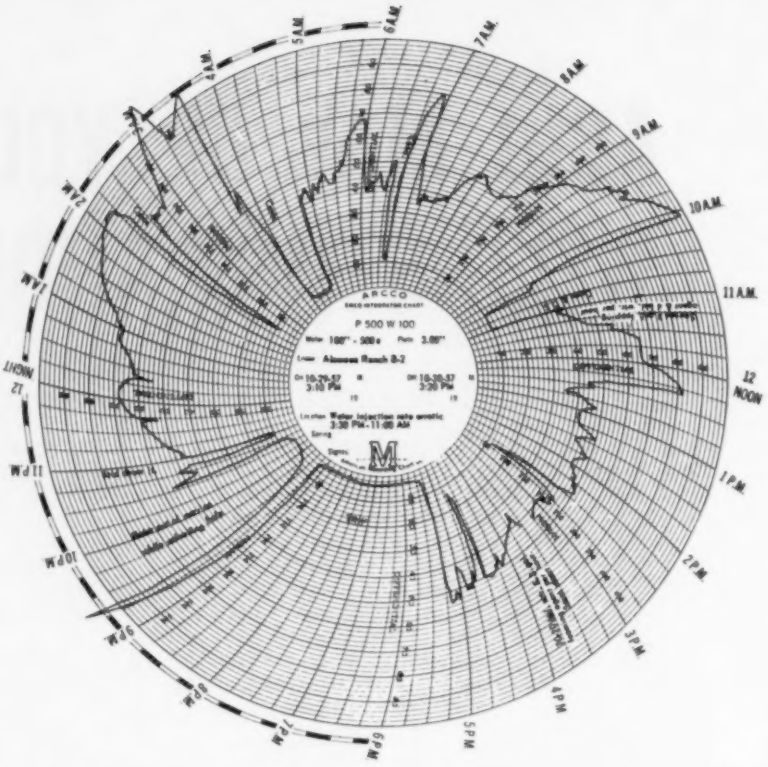

FIG. 3. **Air supply pressure** conditions with varying water injection rates in foam drilling.

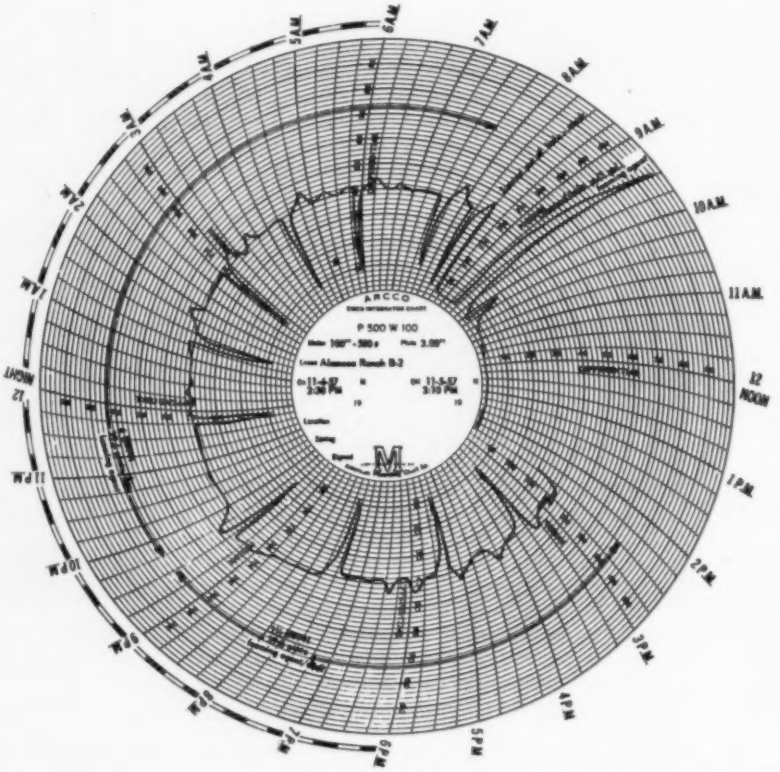

FIG. 4. **Air-supply pressure** conditions with constant water injection rates in foam drilling.

DRILLING PROGRAM

Surface Hole

The 12¼-in. surface hole was drilled to 900 ft with mud and logged to insure that all surface water sands had been penetrated. After reaming to 17¼ in., 13⅜-in. casing was cemented at 851 ft.

12¼-In. Intermediate Hole

After unloading water from the surface casing, drying the hole and drilling the plug, cement and shoe, the hole was flushed clean with foaming agent

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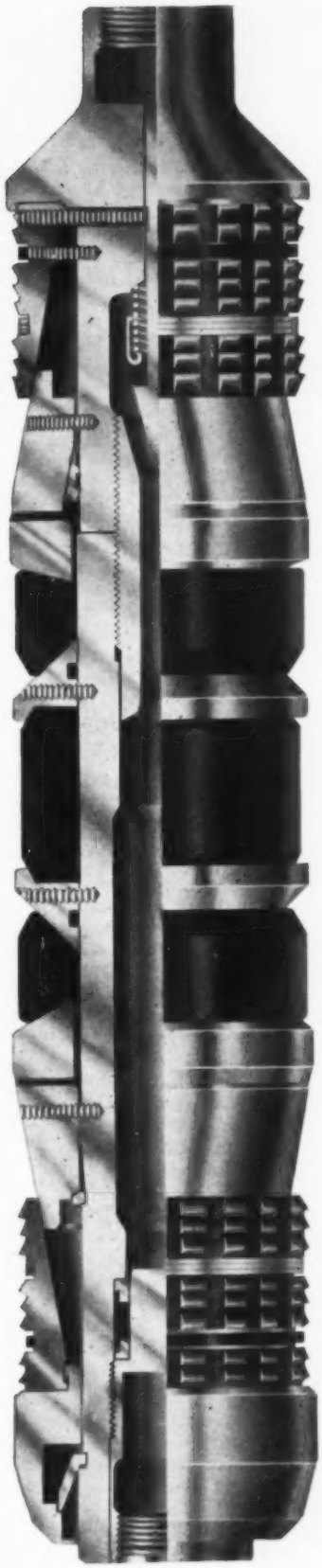


and redried. The 12¼-in. hole from 900 ft to the intermediate casing point at 4177 ft was drilled dry through shale, anhydrite, salt, and dolomite. This section included the Permian "red beds."

Two damp zones were drilled, one at 2013 ft and the other at 3751 ft. In the top zone, the hole continued to dust, but the returns were damp. It was necessary to rotate and circulate out of the hole on a trip at 2441 ft. At 3751 ft most of the dust returns were lost, but after circulating for 45 min and drilling 15 ft, full dust returns were regained. On the next trip, at 4177 ft, over 15 hours were required to get out of the hole. In both cases cutting accumulation on the drill pipe and on the wall of the hole through the wet formation caused the difficulty. Water and foam injection was not initiated in an effort to clean the hole because of the exposed bentonitic shale zones.

From 900 to 2770 ft, the air-circulation rate was maintained at 2100 cu ft per min. At 2770 ft an additional compressor was installed to give 2850 cu ft per min total capacity. Equivalent annular velocity then increased from 2980 to 3850 ft per min and average penetration rate increased from 400 to 610 ft per day. An immediate penetration rate increase from 55 to 73 ft per rotating hour was noted.

8⅝-In. Hole — Air Drilling — Dry

The hole was "mudded up" at 4177 ft and 9⅝-in. casing was cemented at 4174 ft. After conducting various tests with foaming agents in the cased hole, cement was drilled, the hole dried and dry drilling commenced. At 4612 ft, dust returns became damp; and by 4627 ft, all dust returns were lost. In attempting to dry the hole, drilling continued to 4734 ft without cutting returns. A trip at this depth was trouble-free, but wet cuttings were found on the bottom 15 stands of drill pipe. Attempts to dry the hole after this trip were fruitless and drilling proceeded with the injection of water and foaming agent to remove cuttings. Air circulation was maintained at 2100 cu ft per min through this interval with an equivalent annual velocity of 4700 ft per min.

8⅝-In. Hole — Air Drilling — Foam

This entire 1965 ft interval was drilled while maintaining a continuous injection of water and foaming agent. Formation-water influx varied from 1 to 50-60 bbl per hour. Injection rates varied from 1½ to 12 bbl of water per hour with from 1 to 6½ gal of foaming agent. Best results were obtained at a continuous injection rate of approximately 4 bbl of water per hour, with foaming agent amounts varied to suit conditions. A further discussion of these conditions will follow later.

Formations drilled in this interval included hard shale, dolomite, and limestone with some chert. Considerable gage trouble and short bit life were experienced commencing at about 5000 ft. Different type bits proved an adequate solution to this problem and three of these bits were used in completing the air-drilled interval.

When starting out of the hole at 6241 ft, the drill pipe stuck 25 ft off bottom. Five gallons of foaming agent with water were batched into the hole and pipe was free after circulating air for 20 min. No further trouble was experienced on this trip. Either 1400 or 2100 cu ft per min of air was utilized, depending upon the pressure requirements. (Pressures above 250 psi required the use of a booster compressor which would handle only 1400 cu ft per min.) At 6699 ft the hole was "mudded up" to core the two objective zones and drilling continued with mud to a total depth of 7740 ft.

How air drilling compared. The average daily penetration rate through the entire air-drilled interval was equal to 162 percent of mud-drilled well. It is interesting to note that while only 43 percent as many rotating hours were required in the air-drilled well, 62 percent as many total days were required. This variance is explained, at least in part, by the amount of time spent in conducting special tests, training crews, and developing suitable operating techniques. Dry drilling proved to be faster than foam drilling (see Fig. 2). In comparable hard limestone intervals, penetration rate while drilling was 149 percent faster than while drilling with foam. This result was not unexpected because of increased bottom-hole pressures while handling sizable water flows. Foam drilling, however, was still 60 percent faster than mud drilling.

TABLE 1. Drilling Performance Comparison, Mud Versus Air

Item	Alamosa Ranch B-1 (Mud)	Alamosa Ranch B-2 (Air)	B-2 (Air) As Percent of B-1 (Mud)
Dry Drilling 12¼ in. hole 900-4177 Ft			
Average feet per day	205	468	229
Average feet per bit	273	819	300
Number of bits	12	4	33
Rotating hours	208¼	79¼	38
Average feet per rotating hour	15.8	41.5	262
Total days	16	7	44
Dry Drilling 8⅝ in. hole 4177-4734 ft			
Average feet per day	86	279	324
Average feet per bit	93	557	600
Number of bits	6	1	17
Rotating hours	62¼	11	18
Average feet per rotating hour	9.0	50.6	563
Total days*	6½	2	31
Foam Drilling 8⅝ in. hole 4734-6699 ft			
Average feet per day	123	197	160
Average feet per bit	115	281	245
Number of bits	17	7	41
Rotating hours	223½	120	54
Average feet per rotating hour	8.8	16.4	186
Total days	16	10	63

*Does not include running 9⅝-in. casing in either well or mudding up in B-2 for casing — total of 6 days in B-2, 2 days in B-1 (see Fig. 1).

EQUIPMENT, MATERIALS, AND TECHNIQUES

Injection Techniques — Foam Drilling

Maintenance of constant injection rates was found to be necessary for optimum foam-drilling conditions. Varying injection rates resulted in large, hard-to-manage heads of fluid and caused wide ranges of pressure variation (see Fig. 3). Under these erratic conditions, drilling rates slowed at pressure peaks and circulation through the bit was cyclic. Poor circulation-rate stability proved detrimental to bit bearing life unless drilling was stopped during periods of low or no circulation. As an example of the pressure conditions under poor injec-

tion conditions at 5000 ft, surface pressures continually varied from 170 to over 500 psi. At this time a small air-operated boiler feed pump was installed and a constant injection rate was initiated. Pressures immediately leveled off at 190 to 200 psi with occasional small fluid heads requiring only about 240 psi (see Fig. 4).

Volume of foaming agents. Various attempts were made to establish the amount of foaming agent necessary for optimum drilling conditions. The concentration recommended by the manufacturer was one pint of the agent per barrel of total water being handled, or approximately 0.3 percent by volume. Laboratory tests indicate that a good foam is created with somewhat smaller concentrations. In actual practice it is difficult to know the exact amount of water being handled at any one time. However, adjusting the concentration of foaming agent to obtain the most nearly stable surface pressure conditions possible proved a practical procedure.

Bits. A total of 12 bits was used in the air-drilled interval in Alamosa Ranch "B" No. 2 compared to 35 in the same interval in Alamosa Ranch "B" No. 1. Average footage-per-bit figures were 482 vs 166. The maximum footage with one bit while air drilling was 1736 ft through an interval where bits used in the offsetting well averaged 230 ft. Gage wear on standard bit types became a serious problem at about 5000 ft. One standard bit made only 117 ft, a second bit especially designed for full gage hole following it reamed nearly 60 ft and made only 23 ft of new hole, and the following one reamed 23 ft and made no new hole. A tricone bit with tungsten carbide inserts run at 5087 ft made 493 ft of gage hole. Two more of these bits were used in finishing the air-drilled interval with runs of 661 ft and 456 ft through hard shale and limestone.

Corrosion Inhibition

All water used for injection purposes was lime water with a pH of 12 to 13 to inhibit corrosion. Because of the small amount injected as compared to the formation-water flow, pH of returned water at the blooie line was only 7. Intensive slugging with lime to provide an excess was successful in raising terminal pH to 8.5 at one time. Minor pitting of the bottom 2700 ft of drill pipe was noticed after seven days of foam drilling.

Neither the drill collars nor the tool joints showed any evidence of corrosion.

On the next trip into the hole, the bottom 30 stands were swabbed with a solution of an organic inhibitor. The

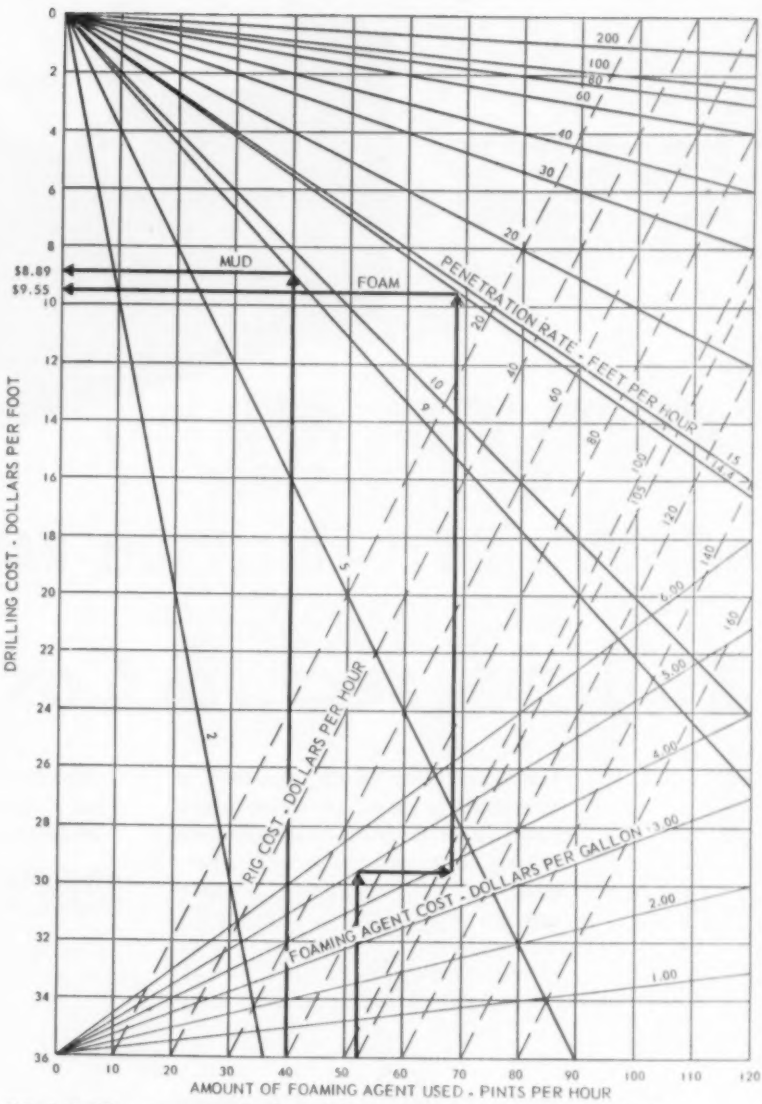


FIG. 5. **Drilling economics** for foam drilling can be determined from this chart.

TABLE 2. Example Problem for Fig. 5.

Given	With Mud	With Air
Rig cost	$80 per hr	$105 per hr
Penetration rate	9 ft per hr	14.4 ft per hr
Foaming-agent cost	—	$5 per gal
Foaming agent used	—	52 pt per hr

To Find Drilling Cost with Mud

A. Locate intersection of $80 per hour rig-cost curve with abcissa.
B. Project vertical line to intersection with penetration-rate curve representing 9 ft per hour.
C. Project horizontal line to intersection with drilling-cost scale and read dollars per foot — in this case $8.89.

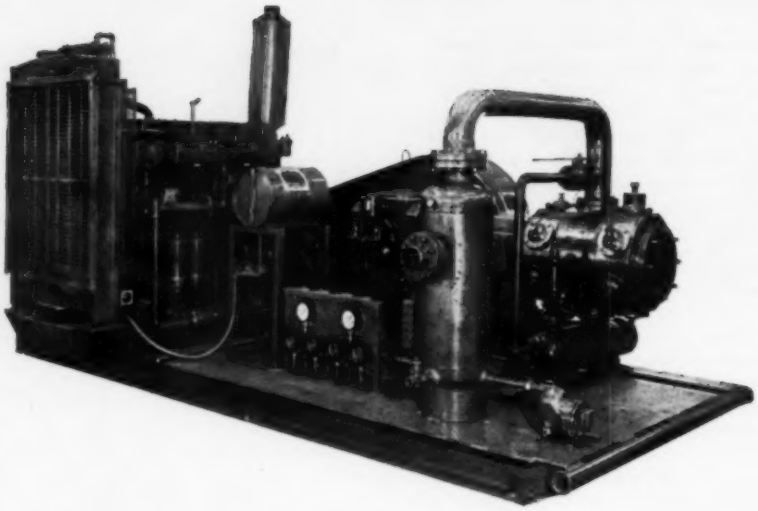
To Find Drilling Cost with Air

A. Project vertical line from point on base scale representing 52 pt per hour of foaming agent to intersection with foaming-agent cost curve for $5 per gal.
B. Project horizontal line to intersection with $105 per hour rig-cost curve.
C. Project horizontal line to intersection with drilling-cost scale and read dollars per foot — in this case $9.55.

Solution

Air drilling with foam costs 66 cents per ft more than drilling with mud. If no other factors, such as lost circulation, are involved, foam drilling is uneconomical.

Ready for the Field: 150 HP, Single Stage, Low Pressure, ESH Wilson Supply-Ingersoll-Rand Compressor. (Sales Gas.)



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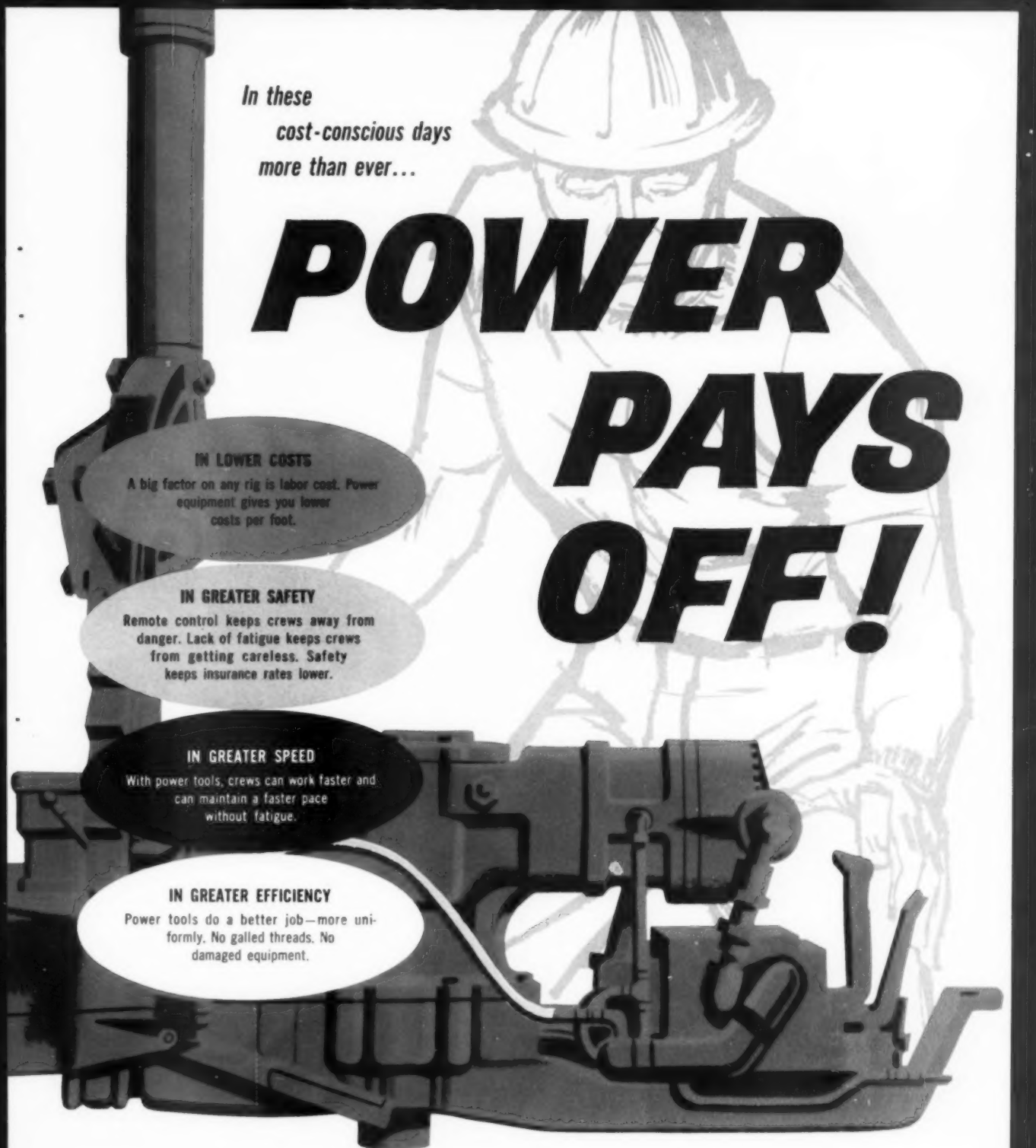

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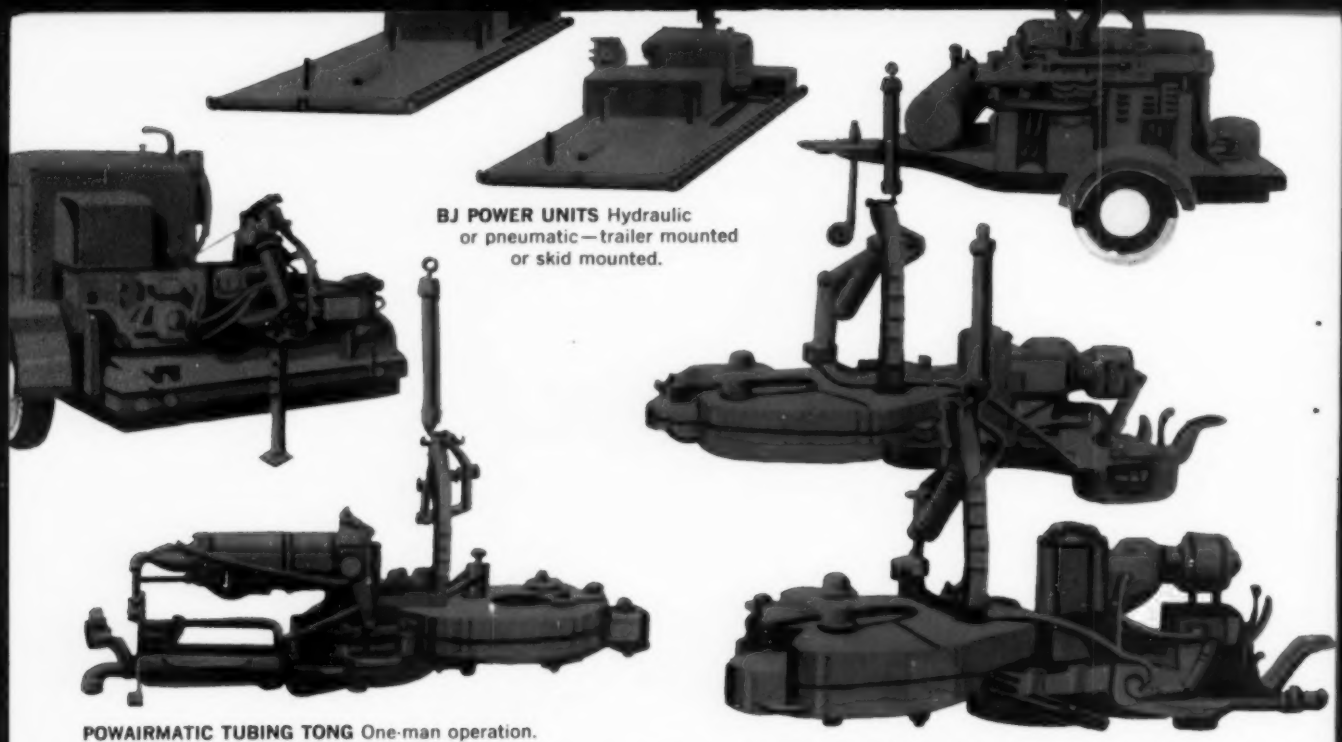

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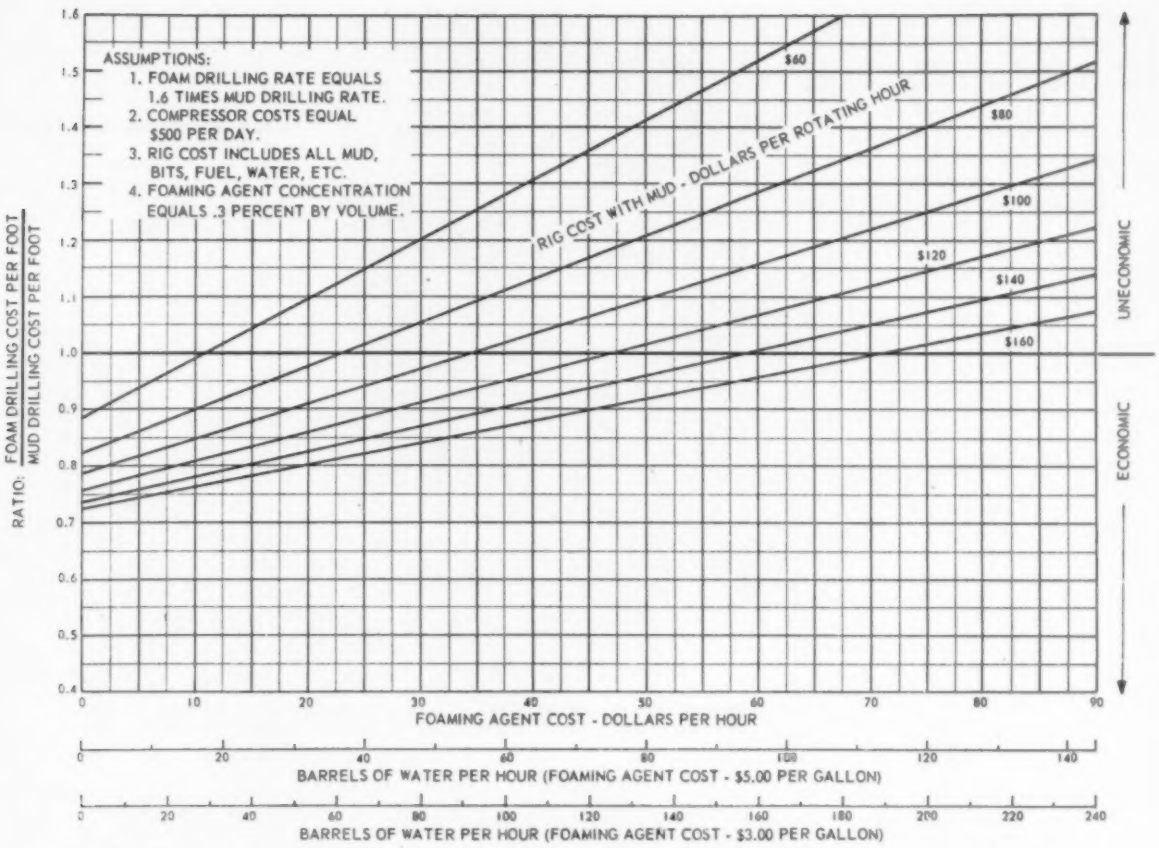
ASSUMPTIONS:
1. FOAM DRILLING RATE EQUALS 1.6 TIMES MUD DRILLING RATE.
2. COMPRESSOR COSTS EQUAL $500 PER DAY.
3. RIG COST INCLUDES ALL MUD, BITS, FUEL, WATER, ETC.
4. FOAMING AGENT CONCENTRATION EQUALS .3 PERCENT BY VOLUME.
RIG COST WITH MUD - DOLLARS PER ROTATING HOUR
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$80
$100
$120
$140
$160
UNECONOMIC
ECONOMIC
RATIO: FOAM DRILLING COST PER FOOT / MUD DRILLING COST PER FOOT
FOAMING AGENT COST - DOLLARS PER HOUR
BARRELS OF WATER PER HOUR (FOAMING AGENT COST - $5.00 PER GALLON)
BARRELS OF WATER PER HOUR (FOAMING AGENT COST - $3.00 PER GALLON)

FIG. 6. **Economic limit** in foam drilling as computed for the assumptions indicated in the upper left hand portion of this chart.

same inhibitor was mixed with the injection water to provide 50 ppm concentration with total water in the hole. Although pilot tests at this concentration showed no noticeable effect on the action of the foaming agent, introduction of the material into the circulation system suppressed all foam. It was necessary to cease injection of this inhibitor immediately and dispose of all contaminated injection water. After swabbing the drill pipe with inhibitor no further external corrosion was noted during the final three days of foam drilling.

Samples

Cutting size distribution ranged from dust to particles approximately ¼-in. diameter. While dry drilling, dust size returns were predominant with air volumes of 2100 cu ft per min in the 12¼-in. hole. After installing additional compressor capacity, larger particles were returned, as large as ⅛-in. diameter. Lag time was negligible while dry drilling.

Foam drilling resulted in larger cuttings, as large as ¼-in. diameter, and pieces of cavings ½-in. diameter were noted from time to time. Lag time became somewhat of a problem, because of heading conditions. Even with the best obtainable pressure characteristics, small irregularly timed fluid heads were noted, and cuttings were carried in great quantity by these heads. At times few cuttings were returned between heads.

Hole Deviation

No trouble with excessive hole deviation was experienced as is sometimes the case in air drilling. Deviation was about equal to the offsetting Alamosa Ranch "B" No. 1 and never exceeded 2 degrees. Bit weights were of the same order of magnitude in both wells, i.e., 20,000 to 35,000 lb.

Equipment

Compressors used on the Alamosa Ranch "B" No. 2 were company-owned equipment with a rated capacity of 2100 cu ft per min at 250 psi. Booster equipment was rated for 1400 cu ft per min at 1500 psi. A 4-in. by 1¾-in. by 4-in. boiler feed pump (driven by air from the supply line) was used to inject water. Foaming agent was introduced at first through a lubricator into the suction of the water-injection pump and later into the discharge by means of two ⅞-in. by 4-in. chemical feed pumps. Use of the lubricator was abandoned because of the difficulty of maintaining an even injection rate.

Metering equipment consisted of temperature recorders on the air-input line and the blooie line, together with an orifice meter to record air volumes.

ECONOMICS OF FOAM DRILLING

Considerable amounts of water were handled successfully while drilling with foam in Alamosa Ranch "B" No. 2. High cost of the foaming agents, however, makes the economics of this technique appear questionable where large amounts of water are encountered, and where lost circulation is not considered. As an example, while handling 50 to 60 bbl of water per hour, 6½ gal per hour of foaming agent were added at a cost of slightly over $5 per gal. On these peak days, over $500 was spent for foaming agents or more than the normal cost for mud maintenance on a mud-drilled well.

Referring to Fig. 5, normal mud drilling of one interval in Alamosa

Ranch "B" No. 1 with a rig costing $80 per rotating hour and a penetration rate of 9 ft per rotating hour gave a cost per foot of $8.89. While foam drilling this same interval in Alamosa Ranch "B" No. 2, the same rig, with compressors added, cost $105 per rotating hour, and made 14.4 ft per rotating hour while using 52 pt of foaming agent. The cost per foot in this case was $9.55, or 66 cents per ft higher than the cost of mud drilling. Had lost circulation not been a factor, the economic limit for foam drilling would have been exceeded at this rate of foam injection (see Fig. 6). In the offsetting well, however, rig time and mud lost while fighting lost circulation averaged $1.40 per ft, giving foam drilling an apparent advantage of 74 cents per ft in this interval.

Foams to extend air drilling. Conclusions drawn from limited experience with foaming agents in one well are certainly subject to later verification or possible change. However, the following conclusions were indicated by the experimental use of these materials in Alamosa Ranch "B" No. 2:

1. Operationally, it is possible to handle large water flows successfully with foaming agents while air drilling.
2. Economically, the amount of water influx which can be tolerated while foam drilling is limited by the cost of the foaming agents and the reduced penetration-rate advantage over mud.
3. Use of foaming agents reduces the circulating pressure requirements while handling water influx.
4. Penetration rates are slower with foam drilling than with dry drilling, but both are faster than mud drilling.
5. Unless inhibitors are used, drill-pipe corrosion can become a problem, even while using saturated lime water for injection purposes.

To summarize, the use of foaming agents is one way to solve the problem of water influx in air drilling. The best solution to this problem is, of course, the most economical one. Development of adequate and economical methods of water shut-off would perhaps be the most desirable solution; however, a lot could be done toward improving the economics of foam drilling by simply developing cheaper foaming agents. In the meantime, the use of foaming agents should extend the application of air drilling and the additional experience gained will, no doubt, permit greater savings to be made than were possible on this early experimental well.

★ ★ ★

A new concept in well head design and construction is represented by OCT's new Unitree line shown at left, compared to its conventional counterpart. Both assemblies are rated at 15,000 psi working pressure.

NEW CHRISTMAS TREE . . .

A Radical Departure in Design Concepts

A RADICAL REWORKING of the design and construction of oilfield Christmas trees has been announced by the Oil Center Tool Company of Houston, Texas, with the introduction of a compact well head unit for single or multiple completions which offers considerable savings in weight and height.

Called the Unitree, it features "built-in" valves which eliminate numerous joints and flanges, reducing the size of the unit and minimizing possibilities of leakage. Valves are inserted into the body of the unitized tree and can be readily replaced in the field.

The first tree displayed by the company is only 43 in. high, but is designed to do the job of a conventional tree 12 or 13 ft high.

Using the basic premise that a Christmas tree is a high-pressure cylinder with additional means to suspend pipe and control fluid flow, a study was made of methods used in the design of high-pressure chambers. The problem resolved itself into a selection of the best method permitting maximum pressure rating with minimum wall section.

The next step was a reduction in the number of flange connections in order to make the tree as compact as possible. This was accomplished by utilizing insert valve components which could be readily installed or removed by one person. Units of this type eliminated the need for flanges. One flange connection is required to connect the assembly to the tubing head or casing spool. Plug-in valve components are furnished by the various valve manufacturers to mate with the bore in the tree.

Weight and height of the unified tree are approximately 40 percent of present equipment of equal pressure rating. The use of a unified tree is more attractive at high-pressure ratings; however, its simplified design will warrant its use in lower pressure rating operations.

While the first development was made for single completion equipment in order to test basic theories and assumptions, the same techniques are readily adaptable to dual completion equipment and such a tree has been developed. The two trees are approximately identical except for the number of valves. Units are available for 2⅜-in. API and 2⅞-in. API tubing. ★

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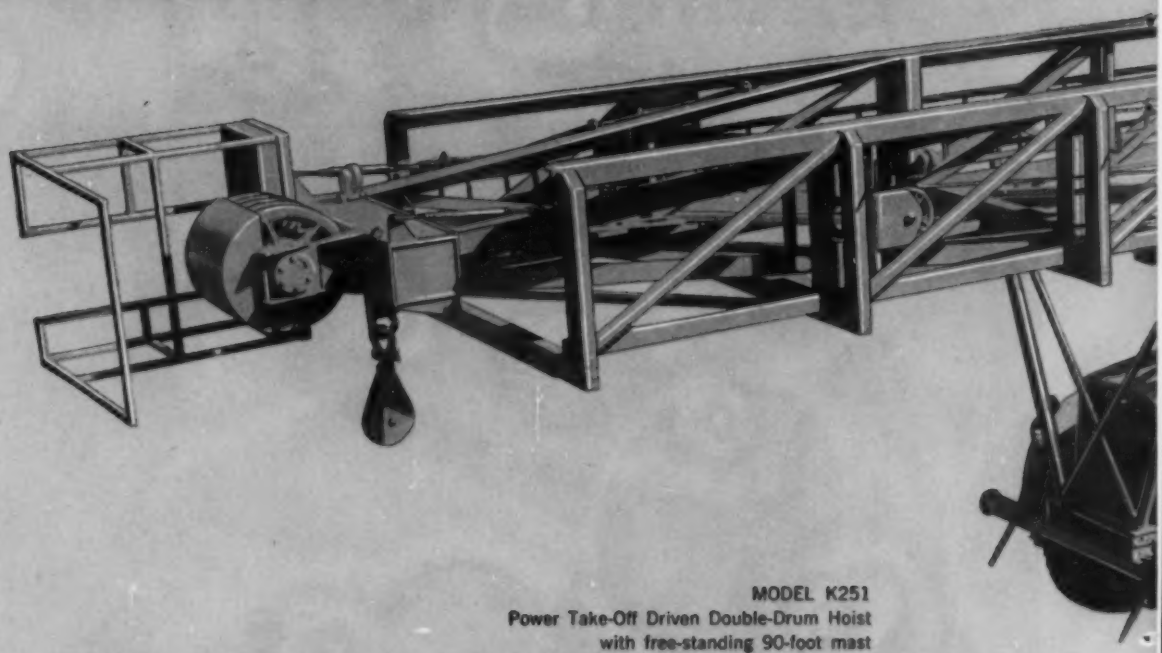

MODEL K251
Power Take-Off Driven Double-Drum Hoist
with free-standing 90-foot mast
170,000-lb. hook load capacity

This outstanding, modern unit meets today's requirements for deep well servicing and workover. The rotary drive, while optional, was engineered as an integral part of the unit. The 90-foot, 170,000-lb. structural mast is designed to rack tubing in doubles and to hang rods in triples. Various heights of single- or double-leg pipe mast are also applicable.

A wide range of truck makes and models will accommodate this Cardwell unit. All controls, including transmission shift, are located at operator's position for efficiency and safety. Recommended depth rating is 15,000 feet with 2½-inch tubing. Unit can utilize up to 350 truck engine horsepower.

available as separate-engine powered double-drum hoist

Cardwell Model K250 is powered by a separate engine, up to 350 H. P. class. It features the same rugged characteristics of Model K251, and can be mounted on a trailer or drive-in type carrier. Ask your nearest Cardwell Representative for full details.

a rugged 15,000-ft. servicing unit

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New Building, New Developments Mark . . .

MAGNOLIA'S 20 YEARS OF RESEARCH

Inverted emulsion cements, seismic TV monitoring added to lab's achievements; 25,000 sq ft lab addition completed

MAGNOLIA Petroleum Company marked its 20th anniversary of exploration and production research recently by the announcement of new scientific developments and the construction of a large laboratory building at its Dallas, Texas, suburban headquarters.

The company's laboratory has grown from a two-room lab established in 1938, to an organization of 25 buildings spread over 20 acres near Duncanville, southwest of Dallas.

Adding to Magnolia's long list of scientific achievements in the exploration and production field, Dr. C. Ivan Alexander, manager of the field research laboratory, made public several new developments during the anniversary week of March 24 to 28. These included an inverted emulsion cement, the use of television monitoring in the interpretation of seismic logs, and advanced work with inverted emulsion completion fluids.

Research History

The field research laboratory was established on March 3, 1938. The late Fred M. Lege, Jr., at that time vice-president of Magnolia Petroleum Company, announced the creation of the laboratory in the Magnolia Institute Building on McKinney Avenue, Dallas. This laboratory was to do research work on natural gas utilization under the supervision of the natural gas and gasoline department. The lab's present location of approximately 144 acres was purchased May 30, 1940. The construction of several buildings began in August 1940. A pilot plant, an office building, a general laboratory, and a machine shop were completed in November of 1940 and at that time the transfer of personnel from the old McKinney location to the new Duncanville site began. Building construction continued during 1941, at which time facilities were provided for the natural gas department's laboratory, a power house, and a second pilot plant.

During World War II, the laboratory's assignment was broadened to include research on refinery processes and on oil exploration. The rate of hiring was stepped up, and, as the staff became larger, more buildings were erected. Considerable emphasis was being given to research and pilot plant development work on the production of aviation gasoline, synthetic lubricating oils, and catalyst manufacture.

By 1943, the transfer from the McKinney site was completed and the laboratory's staff had increased to 163 employees. The laboratory's organization consisted of six sections: Chemical research, physics research, development, design, patent, and service. The chemical research section and the development section naturally evolved from the original laboratory organization. The physics research section obtained a number of its original personnel from Magnolia's geophysical department. This personnel subsequently formed the nucleus of the present exploration research division. Staff expansion and construction continued in 1944 and 1945 until the end of 1945 the staff numbered slightly more than 300 persons.

Early in 1946, a general reorganization of the Socony laboratory system occurred. The total research effort of Socony and its affiliates was concentrated into three units: The Field Research Laboratory, Dallas, Texas; the Research and Development Department, Paulsboro, New Jersey, and the Technical Service Department, Brooklyn, New York. The field research laboratory was assigned the responsibility for conducting all phases of research in the fields of petroleum and natural gas exploration and production for the entire Socony organization.

As a result of this change in assignment, the field research laboratory staff was reduced to 150 employees. Three divisions, the exploration research division, the production research division, and the general services division replaced the six sections which were active under the previous organization.

Physical Plant

Since 1946, the staff of the laboratory has been increased gradually until today the laboratory employs about 380 people.

Construction has continued to keep pace with the expanding research program. Between 1946 and 1951, construction was essentially limited to conversion, modification, and extension of existing buildings. Additional space for administrative personnel was provided in 1953 with the construction of the administration building.

In the fall of 1956, construction was started on a new building which will provide 25,000 sq ft of added floor space. This building represents the initial phase of a long range building program designed to provide the laboratory with additional space totaling 75,000 sq ft.

The new structure contains 25,000 ft of floor space, housing 21 separate laboratories, the lab's library, its electronic computers and 34 offices. Other space will be used for the building mechanical equipment, instrument shop, electronics shop, photographic laboratory, and other miscellaneous operations.

The building is designed to be two stories. The first phase consists of one story with a partial basement, and provides a total floor area of about 25,000 sq ft. It is planned that an additional 29,000 sq ft will be added about 1960 by building the second floor and adding two 24 ft bays at the end of the building. There will be a connecting link between the new building and the present administration building. The dimensions of this link are 40 ft wide and 70 ft long.

Scientific Contributions

Several outstanding scientific developments in the area of exploration

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Thousands of grueling hours on tough jobs like salt water disposal, and this HD-11 is still going strong.

"Brother, that takes a good *crawler*—and the HD-11 sure measures up!" says M. F. Machen, Texas oil field contractor.

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Midland, Texas

HD-11
94 belt hp
24,600 lb
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HD-11 cleans up shale pit and reservoir. Operator J.W.Thompson is "mighty pleased" with his machine.

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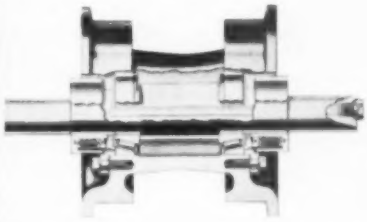

costly maintenance to a minimum. 1,000-hour lubrication intervals for everything below track level means extra production time every day—hundreds of hours every year!

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Look ahead... *move ahead* ...and stay ahead with **ALLIS-CHALMERS**

and production from Magnolia's field research laboratories include:

Development of subsurface combustion theories. Although several other oil company laboratories have done work on "subsurface combustion," Magnolia claims to be first to field-test and publish its findings.

Calcium surfactant mud was developed by the labs for deep drilling in areas of high bottom-hole temperatures and pressures.

The continuous velocity logging tool, that distinguishes one underground formation from another, has been licensed to service companies.

The Marine Sonoprobe is an instrument that explores and maps the ocean floor and the shallow sediments beneath it by sound waves; it is being used to determine routes of underwater pipelines, locate oyster beds, and by the U. S. Army for mapping purposes.

Magnolia has received over 200 patents on the laboratory's work since World War II, and 100 more are pending. It holds a dozen licenses with service companies for tools and techniques, and another half-dozen are in the mill.

Recent Developments

In recent months, a formulation for the preparation of inverted emulsion completion mud has been developed in the laboratory. These fluids permit essentially damage-free completions to be carried out. The laboratory staff has now gone one step farther by introducing an inverted emulsion cement. This cement is designed to keep water from damaging formation in the cementing phase of completion.

In the field of geophysics, Magnolia is making use of the television monitor to "make the most" of seismograms. Seismic crews now are able to shoot their patterns "wide open," and let the technicians filter out —in the lab— unwanted noise and print the best possible seismogram. This permits field crews to move faster by cutting re-shooting time and eliminating the necessity of making field prints. ★ ★

In playing back magnetic taped records . . .

TV Monitor New Aid in Seismic Interpretation

Magnolia Petroleum Company is using an ordinary television screen to expedite interpretation of seismograms. By selecting the best seismic profiles in the laboratory rather than in the field, geophysical technicians are able to print only the ideal seismogram. This technical use of the common TV is saving considerable time and expense, company officials say.

Simplified, the TV monitoring method works like this. Seismic crews in the field record their "shots" on magnetic tape with recording instruments set to receive "everything." Formerly, the crews had to re-shoot locations if low-volume seismic records, then printed in the field, failed to give an adequate profile. Likewise, if the shot were recorded too "loud," no delineation would be possible. In any case, the shot holes would have to be redrilled, more dynamite would be used and more field prints made.

Now, no field prints are made and no field corrections are necessary. The seismic crew now records one magnetic tape. One shot pattern is taken and the crew moves on. These are sent to the lab for analysis and the tapes are played back and a paper record is made of it. However, between the tape and the paper record, a 24-in. TV screen monitors the trace signals. By adjusting controls on each of 12 traces displayed on the screen (24 traces are on each tape; one-half of the tape is shown at one time), the technician selects for printing the best picture with the least interference.

Dr. C. Ivan Alexander, Magnolia's field research laboratory manager, states that "With the monitor, we can see the results of filtering and we know when we have the best record possible."

To carry the work one step farther, several seismic records are put together to form a profile, or cross-section, of the earth's subsurface. Frank J. McDonal is geophysics research group leader at the field lab in charge of the project. ★ ★ ★

Sounds of the earth are like mazes as they are played back on a TV monitor from a magnetic tape. Magnolia lab technician Basil Kersey filters out "noise" on the TV monitor as a seismic record is being made from a geophysical magnetic tape.

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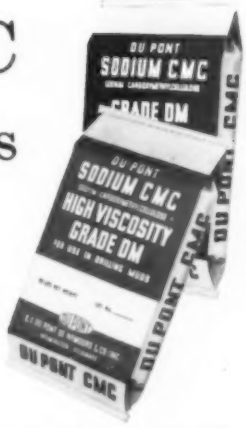
Du Pont Explosives Department, offices in Dallas, Los Angeles and Wilmington. Warehouse in Farmington, New Mexico.



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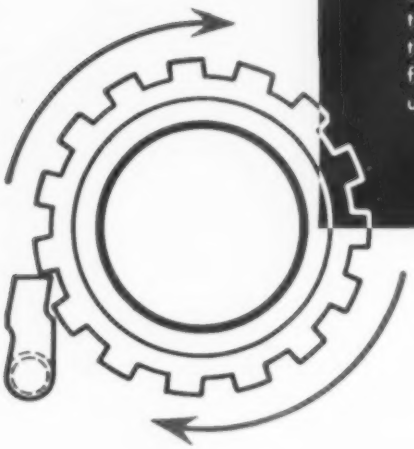
During a research program, Cameron engineers subjected every type of conventional valve to wear by opening and closing against high pressure abrasive flow. In the course of these tests it developed that the downstream seat on each valve showed the most wear, whereas other sealing surfaces in the valves were relatively undamaged.

Maximum wear always occurred at the same point on the seat. Then a new idea was conceived. Rotating the seat a fraction of a turn each time the valve was opened and closed would present a new surface at the point of greatest wear each time the valve was operated. This principle is the central feature of the new Cameron Type "F" gate valve.

The same carefully controlled tests which produced such destructive wear on the conventional valves were re-run with the Type "F" gate valve. The remarkable results exceeded every expectation. Here for the first time is a valve with such unusual durability that it can perform any W.O.G.M.* service for many times the life span of any valve used in drilling and production service.



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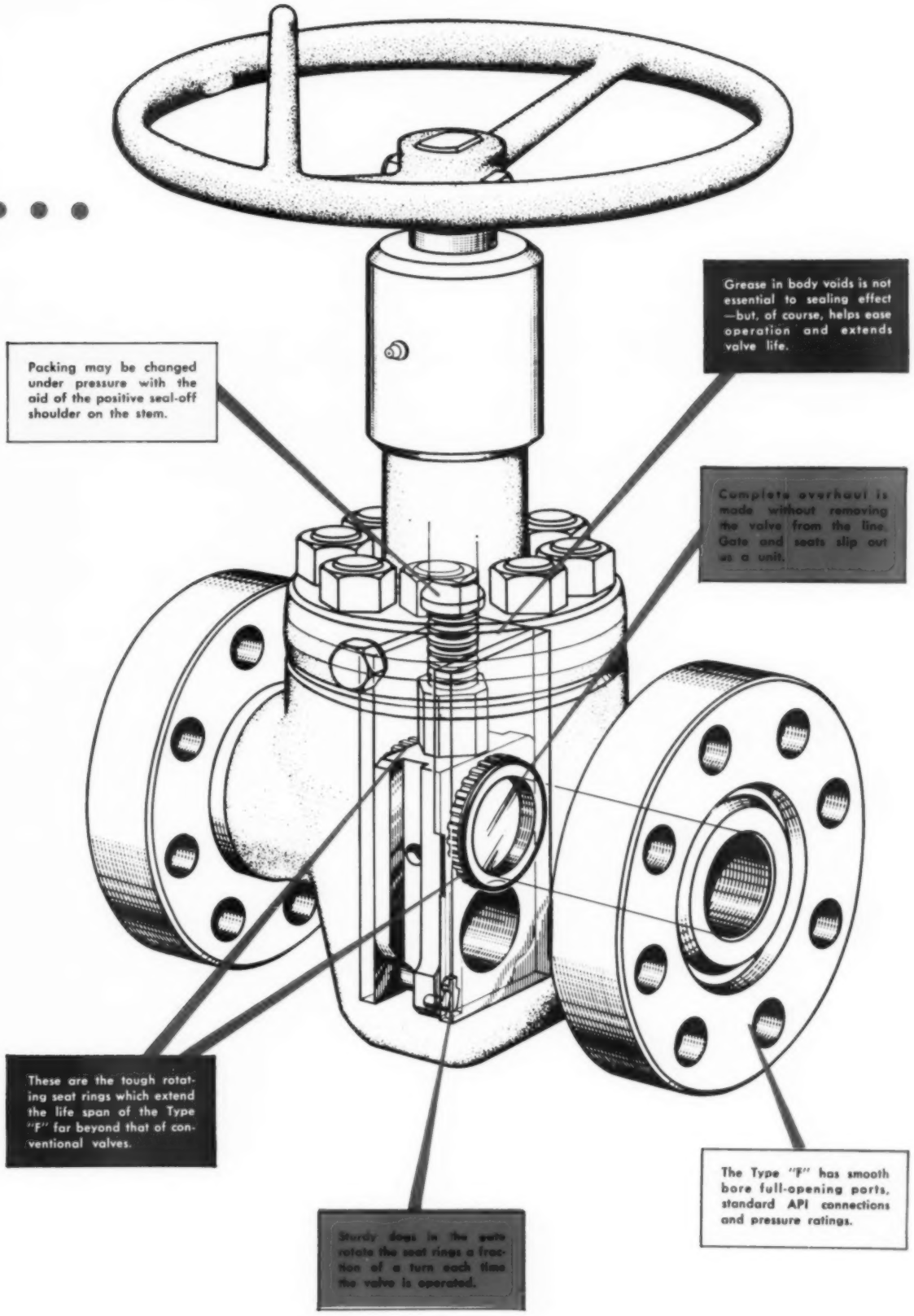
**Water Oil Gas Mud*


Grease in body voids is not essential to sealing effect—but, of course, helps ease operation and extends valve life.
Packing may be changed under pressure with the aid of the positive seal-off shoulder on the stem.
Complete overhaul is made without removing the valve from the line. Gate and seats slip out as a unit.
These are the tough rotating seat rings which extend the life span of the Type "F" far beyond that of conventional valves.
The Type "F" has smooth bore full-opening ports, standard API connections and pressure ratings.
Sturdy dogs in the gate rotate the seat rings a fraction of a turn each time the valve is operated.

Pressure Ratings through 15,000 p.s.i. W.P.

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Offshore drilling tender has recently been added augment Shell-BP's accelerated drilling program in Nigeria. The tender, which was built in the Netherlands, will be used in conjunction with a 12,000 ft drilling rig mounted on pilings. It is being used in the tidal mangrove swamps of the delta of the River Niger. This is the tender as it arrived at Port Harcourt, Southern Nigeria.

More rigs than producing wells . . .

Nigeria *Gears for Major Oil Program*

Shell-BP consortium doubles drilling activity this year; gathers first commercial oil — fruit of 20 years' labor

Water transport base at Warri. From here launches carry supplies to seismic and gravity parties still working in the Niger delta swamps. On the left is a houseboat that provides living accommodations; at right is a new floating dynamite magazine under construction. The company has 5 other houseboats, 10 launches, 2 tugs, 2 LCM's and an LCT. This in in addition to 90 staff cars and pickup trucks, and 120 heavy trucks and trailers and several buses that traverse Nigeria's washboardroads.

AT LONG LAST the Oloibiri oil field in the Brass division of East Nigeria is producing petroleum. This puts Nigeria on the world oil map. The first cargo of 1200 bbl of crude oil left the tank storage farm at Kugbo Creek by barge on Christmas Day, 1957, arriving at the Port Harcourt storage terminal the following day. Behind this lies the story of two decades of endeavor and an outlay exceeding $33,600,000. This sum may soon be considered small considering proposed and existing plans for oil development.

Two Producing Fields

So far two oil fields – Oloibiri and Afam – both located in East Nigeria near Port Harcourt have been found. Four successful wells have been drilled at the former location and three at the latter. Ten drilling rigs are already in operation and the Shell-British Petroleum consortium plans to double its drilling activities this year. It is, however, reckoned that a minimum output of 100,000 bbl a day will be required before full-fledged commercial petroleum production can take place in Nigeria.

In 1937 a handful of geologists landed in Nigeria and launched one of the most protracted, difficult and costly oil searches of all time. The small cluster of pioneer oil men living in tents then, has now blossomed into a vast organization housed in a spacious self-contained camp. More than 2300 persons are at work, of whom over 2000 are Nigerians. The present operating concern is the Shell-D'Arcy Petroleum Company of Nigeria Ltd.

Oil Reconnaisance

Search for oil in this part of tropical Africa falls into three phases: Reconnaisance, semi-detailed and detailed exploration, and deep-test drilling. Initial work commenced in 1937 with a broad and rapid survey over the entire sedimentary area from Lagos in the west to Yola in the east, and from Calabar to Sokoto. Subsequent prospecting was confined to the southern sedimentary region for which the Nigerian government issued an exploration license to the Shell-D'Arcy Petroleum Company.

Exploration

Under the second phase, lasting from 1938 to 1941, the company continued the geological work and carried out gravity surveys in the Onitsha/Okigwi/Owerri areas, and in the

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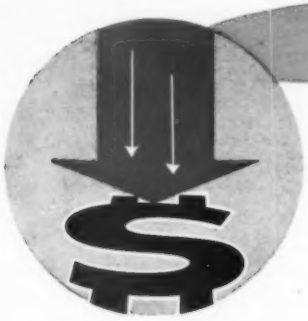
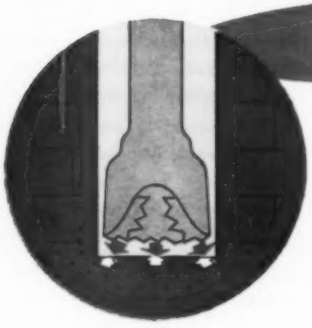


KEEP COSTS DOWN

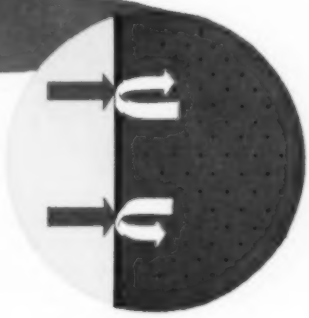
GET FASTER DRILLING

MAINTAIN CIRCULATION

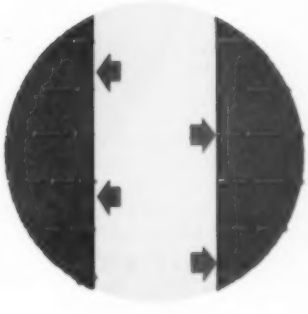
MUD WEIGHT HIGH ENOUGH TO...



PREVENT BLOWOUTS



HOLD BACK SALT WATER



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Injection Well for Water Flooding Project, Caddo Parish, Louisiana

Injection Distribution Manifold for Water Flooding Project, Caddo Parish, Louisiana

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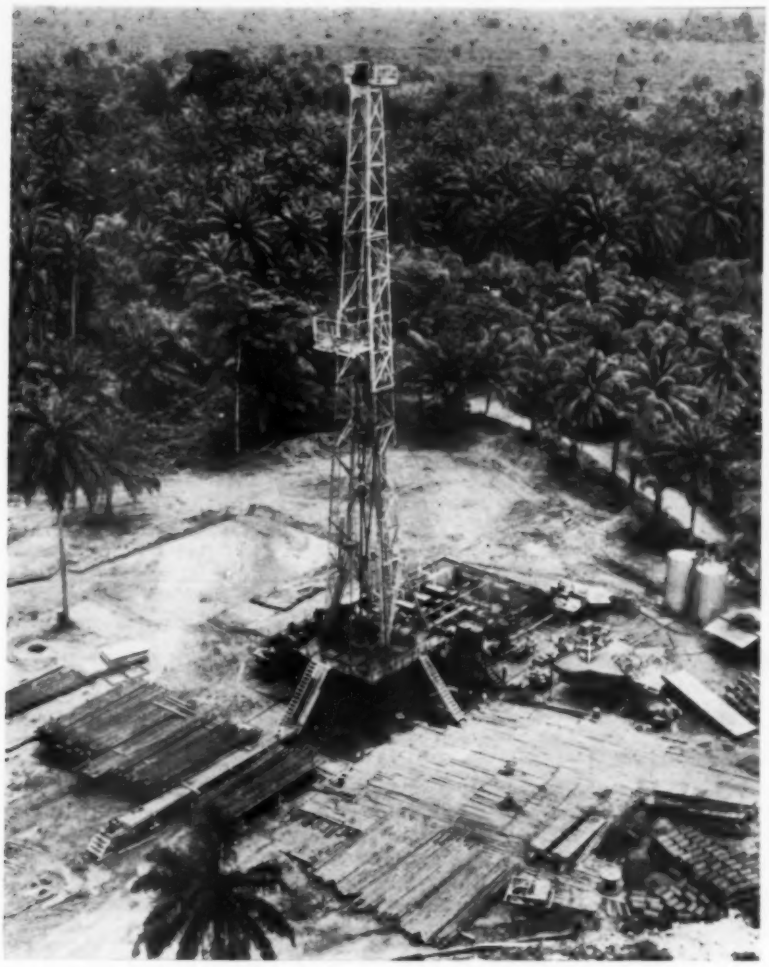

An American-made drilling rig drilling at Akata, in the Calabar Province. This is one of 10 now being used to extend oil finds at Oloibiri and Afam fields.

Deltaic tract; one seismic party was active in the Okigwi/Owerri/'Imo River region. In addition, several shallow core holes were drilled in the Awgu/Ishiago/Ngusu areas. This work suffered an interruption in 1941 because of the war, and was not renewed until September 1946.

Two geological parties then resumed work, and geophysical operations were re-started in 1949 with one gravity and one seismic party. One of the major problems at this juncture was that a substantial part of the concession area was covered by the Niger delta, for which there was virtually no accurate topographical map. For this reason, the company was forced to map some 15,000 sq miles of the delta by aerial survey, and this formidable undertaking could only be completed in April 1953 owning to trying local climatic conditions.

Test Drilling

The third phase began in 1952. The first deep test well reached a depth of 11,000 ft before it was abandoned. In the following year a well drilled with an American-made rig encountered showings of oil at Akata, associated with a considerable volume of gas. In 1954 this outfit was moved to Nzam on the Niger banks north of Onitsha. At the same time, a smaller rig drilled test holes near Okigwi, Ituk Mbang, and adjoining Benin City. In May 1955 the Nzam well was abandoned at a depth of 12,046 ft, a record depth for Nigeria, following disappointing test results. The smaller rig was drilling a well at Umuna in Owerri Province in the autumn of 1955. The Dutch contract rig was drilling an outstep well in the Akata area, after completing a well at Ekim in Calabar Province where promising oil shows were found.

Distances are vast in Nigeria and the available highways are often a nightmare to the most stoutly-built vehicle. Drilling rigs and seismic parties must be assured of regular supplies of food, equipment, tools and fuel. Moreover, the expatriates want their mail regularly and need transport back to base occasionally for well-earned recreation.

A fleet of 90 staff cars, pick-ups and land-rovers are maintained for this purpose. Then, when a drilling rig or seismic party moves location, the heavy trucks and trailers — some 120 strong — come into play. Buses for school children and bicycles for messengers just about complete the items of land transport. Where operational areas are inaccessible by road, the inland waterway network is used. The company operates two LCM's and one LCT for heavy transport, six houseboats for accommodating personnel, 10 launches and speed boats and two tugs. Finally, air transport, comprising three helicopters, is proving an asset.

Shell-D'Arcy employs around 300 expatriates on its staff. They come with their families to live in a country where there are few outside forms of entertainment, and the climate and the diseases still command respect and care. In this context, Owerri's residential area contains family bungalows, bachelors' quarters, and a rest home for temporary residents and visitors. A large up-to-date club provides the much-needed focal point for dances, social gatherings, and indoor games. Although most of the Nigerian staff lives outside the camp in their own houses, their welfare has been the particular concern of the company. They have a well-equipped club-house and amenities for playing cricket, football, and tennis.

Oloibiri Wells

At Oloibiri on the Niger River delta three wells encountered oil in three separate thin sands between 8000 and 9000 ft. Oloibiri drilled four during the first quarter of 1957 that proved dry and appeared to establish the southern limit of the field. A fifth well was drilled in mid-1957. Here the three producers completed during 1956 and in early 1957 are 3937 ft apart. They are located in an area of very difficult accessibility in the Niger River delta.

Further north, a second well was drilled last year at Akukwa in Onitsha Province in the hope of finding oil associated with high-pressure gas which caused a blow-out, when the first well on this structure was drilled to 12,000 ft in 1955. This test was also reported dry, however. At Ibotio in the Calabar Province a wildcat drilled in 1956 encountered a thin oil sand. In all, five exploratory and four appraisal wells were drilled during 1956 aggregating 60,000 ft. Three drilling strings and four seismic parties were operating in

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trimmed Orbit valves.

the same year. At Afam, 20 miles east of Port Harcourt, a wildcat tested oil and gas; and a second well, three-quarters of a mile north of the first, was started late in 1956. In mid-1956 the Shell-BP consortium announced a new wildcat location for a 10,000 ft test, 16 miles south of Benin City mid-day between Lagos and Port Harcourt. In 1954 a well northwest of the latter city found a non-commercial oil show at 6387 ft.

Drilling Tender

Designed to help in the drilling for oil in the tidal mangrove swamps of the Niger River delta, an all-steel floating tender has reached Port Harcourt, after being towed for over 4000 miles by sea from Holland. It includes a helicopter landing platform — the first of its kind to be used in the new phase of the expanding Nigerian oil search activities. This vessel has a draft of 8 ft, is 158 ft long and 80 ft wide. Apart from the drilling unit, which is fixed on a platform placed on piles and driven into the sea bed, the tender houses all the machinery, plant, fuel and stores necessary for this kind of operation. It can support non-stop drilling operations for up to 30 days. It will mount a rig capable of 12,000 ft depth. Its first location is likely to be in the New Calabar River estuary near Krakrama in Degema division nearly 20 miles south of Port Harcourt. The delta tidal swamps, where no test wells have been drilled, form part of the company's prospecting area which altogether covers nearly 40,000 sq miles.

Also, a brief marine survey was conducted in November 1956 to assemble data relating to possible oil exports from Nigeria by tanker, which indicated that Calabar, Port Harcourt, and Lagos permit vessels of 18, 21 and 25 ft of draught respectively.

Two of four productive wells at Oloibiri have been accounting for oil on test and the other two started production early in January (1958). Until recently, transport of this crude oil was carried out in two stages. It was pumped from the wells through an 8-in. pipeline over a distance of 7 miles to the tank storage farm at Kugbo Creek, from which it was loaded into barges and towed to Port Harcourt. In March a 10-in. pipeline was completed and transport by barge was discontinued. Oloibiri's output is now pumped directly to Port Harcourt. Estimated production is 4000 bbl a day. Oil transport by ocean tankers began in February after sufficient stocks had been built up at the port. Loading to only half capacity of modern tankers is possible, however, because of insufficient depth of water at the entrance to the Bonny River. ★ ★ ★

Mid-Continent API production meeting . . .

API: Beware of Big Government

The threat of big government is the biggest cloud hanging over the oil industry today, warned speakers at the Mid-Continent Division District, API, Division of Production. Many voiced appeal for protection and preservation of the free enterprise system at the group's three-day meeting, April 9-11 in Oklahoma City, Oklahoma.

About 750 oilmen from Oklahoma, Kansas, and the Texas Panhandle attended the district meeting.

Sid Latham, vice president of Hunt Oil Company of Dallas, Texas, in a key address before the group, pointed out that Americans face "The spectacle of 40,000,000 haunted houses — haunted not by ghosts in the superstitious sense — but by big government." With every acceptance of federal aid we accede to a bit more federal control, Latham pointed out.

Another API speaker, Kenneth McFarland, educational consultant of General Motors, Topeka, Kansas, admonished us not to "panic and run the free enterprise vehicle into the ditch." He advised the group that "the younger generation" has never been taught the basic tenet of the free enterprise system — the law of supply of demand; the older generation has forgotten it, he claims.

J. Ed Warren, senior vice president of the First National City Bank of New York, pointed out that the long range prospect for the oil industry was bright, but held little optimism for better conditions within the domestic industry in the next few months. Warren addressed the group at one of the four general sessions of the Mid-Continent group.

Wayne C. Moody, Sunray Mid-Continent Oil Company, Tulsa (center), is new district chairman for the Mid-Continent District of the Division of Production, API. Congratulating him are (left to right): Fred J. Neslage, re-elected district vice chairman for the Texas Panhandle; E. E. Young, who preceded Moody as district chairman; Moody; D. L. Connelly, vice president of the API for production, and J. F. McDonald, district vice chairman for the Seminole-Oklahoma City area.

Committees and study groups reporting at the session told of achievements in both the fields of production and drilling. Two new study groups were established. One group was set up to work on possible new specifications and new equipment for handling high tensile drill pipe, casing and tubing being used in today's deeper drilling. A second group was set up to study water analysis.

New Officers, Citations

Wayne C. Moody, Sunray Mid-Continent Oil Company, Tulsa, was elected to serve as the new district chairman for the Mid-Continent District Division of Production. He was formerly chairman of the program committee for the district meeting. He succeeds E. E. Young, Sohio Petroleum Company, Oklahoma City.

Other district officers elected include: Vice Chairman for the Seminole-Oklahoma City area J. F. McDonald, Gulf Oil Corporation, Oklahoma City; Vice Chairman for Kansas A. L. Dunn, Walter O'Bannon Company, Great Bend, Kansas; Vice Chairman for the Drumright-Perry area B. R. Ermey, Schlumberger Well Surveying Corporation, Perry, Oklahoma; Vice Chairman for the Texas Panhandle Fred J. Neslage, West Pampa Repressuring Association, Pampa, Texas; Vice Chairman for southern Oklahoma Jack P. Denny, Phillips Petroleum Company, Ardmore, Oklahoma; Vice Chairman for the Golden Trend area W. B. Faught, Vickers Petroleum Company, Inc., Pauls Valley, Oklahoma; and Secretary-Treasurer Ralph W. O'Neill, Phillips Petroleum Company, Phillips, Texas.

Five received "Citations for Service" by the district. The awards were made by D. L. Connelly, API vice president for production to: Jack Abernathy, Big Chief Drilling Company, Oklahoma City; L. F. Davis, Atlantic Refining Company, Tulsa; M. L. Powers, University of Oklahoma, Norman, Oklahoma; Jack Tarner, Phillips Petroleum Company, Bartlesville, Oklahoma, and J. Zaba, Pan American Petroleum Corporation, Tulsa.

P 420.5

As drilling goes, so goes the industry . . .

Economic Outlook for the Drilling Contractor

Future of the entire drilling and production industry depends on the ability of the oilmen to cut drilling costs; cutting drilling cost depends on the ability to decrease drilling time

Jack H. Marsee,
Loffland Brothers Company
Tulsa, Oklahoma

THE CURRENT RECESSION in all business activity is also affecting the petroleum industry. There has been a decline in the growth of demand which led to accumulation of excess stocks of both crude and products. The result has been curtailment of production and reduced drilling activity.

A situation that is of more lasting significance than the current recession has developed from increasing costs for drilling. Factors peculiar to the nature and history of operation of the oil industry have made it increasingly difficult to raise the price of crude and products to keep pace with rising cost. The average price of crude has been increased but once in four years. The approach of cost to price obtained is believed to have contributed to the decline of domestic drilling activity. Continuance of this situation is a serious threat to the progress of both the drilling and producing industries.

The contract drilling industry has made a significant contribution toward holding the cost level by reducing drilling time required. While reducing the footage price, the contractor's cost-profit margin has narrowed so that further improvement in technology and equipment will be slowed by lack of funds.

The progress of both the domestic drilling and producing industries depends upon the ability to drill more hole at less cost. The current bare-existence level of return to the contractor does not create the necessary economic situation to reduce drilling time further. This is the wrong approach to the problem. The contract drilling industry must be maintained in a healthy economic position to be able to make the required investment in men, tools, and methods. Any approach less farsighted will be costly to both the drilling and producing industry.

The economic outlook for the drilling contractor is directly related to the economy of the producing industry.

Drilling Affects Entire Industry

Present recessionary conditions in this country are affecting all industries. Nevertheless, in a dynamic economy such as ours, the effect should be short-lived. The long-range results are those which are of greatest importance, and the long-range forecast of petroleum requirements is encouraging. However, current conditions in the petroleum and drilling industry cannot be ignored, even in the long-range picture, for these conditions have been developing for some time and thus may be the beginning of a new trend. Certainly, prior to the beginning of the present recession in this country, there had already developed significant changes in the overall petroleum industry. The recession has focused attention on these developments.

When the Suez Canal was opened last year, the domestic export volume immediately began to decline toward the pre-closing level. Producing capacities had been geared to meet the export volume required by closing the Canal, thus there was a stock growth created by inability to slow production at a rate equaling the decline in export demand. The stock growth that occurred caused no undue concern because of anticipation of the seasonal increase in demand during the winter months. The anticipated demand growth, based on observation of past growth, had been set at 4.3 percent per year.[2] The actual demand growth from June 1957, through November 1957 was only 2.1 percent higher than for this period in 1955. Early forecasts for the crude demand for 1958 vary from predictions of a small decline to a gain of only 1½ percent over the total crude demand for 1957.

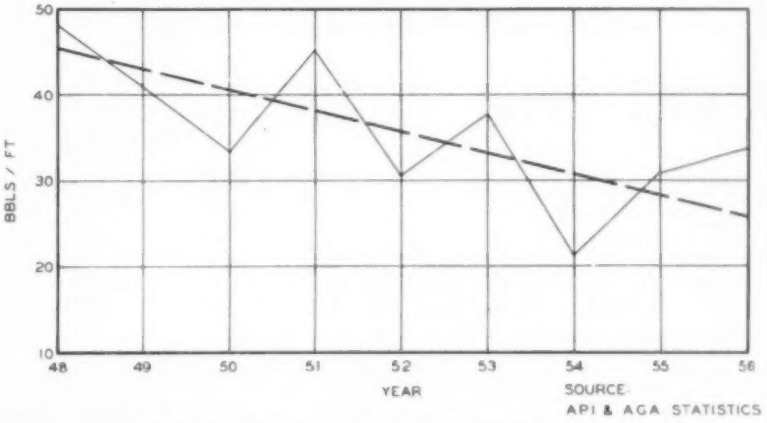
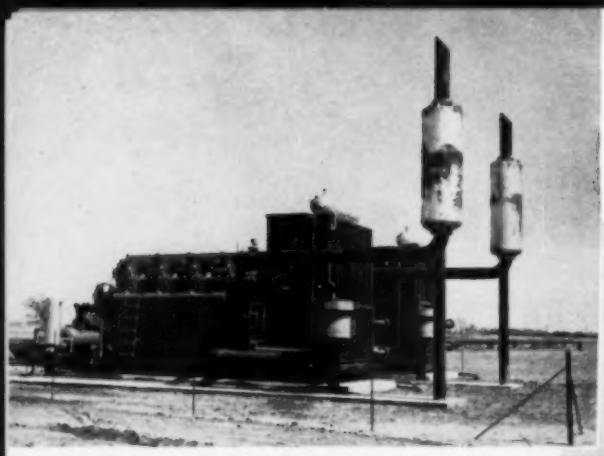


FIG. 1. **Total hydrocarbons found** per foot of hole drilled (by year) has shown a steady downward trend in recent years.

"The Economic Outlook for the Drilling Contractor" was presented at the spring meeting of the Rocky Mountain District, American Petroleum Institute, Division of Production, in Denver, Colorado, April 22, 1958.



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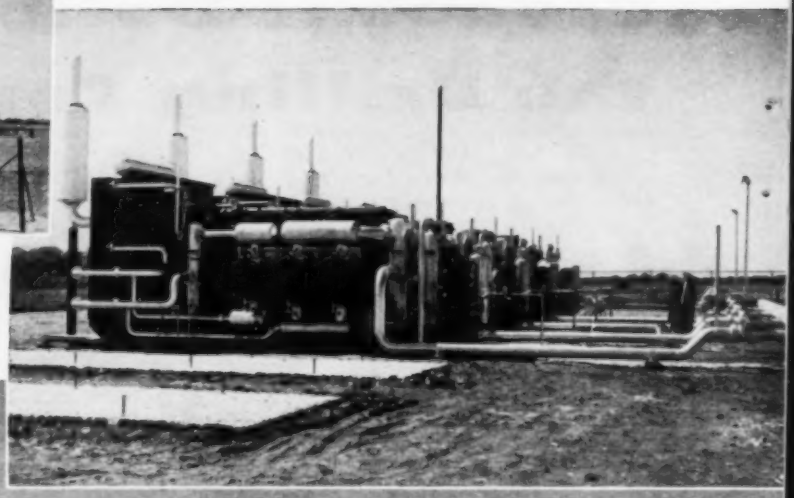

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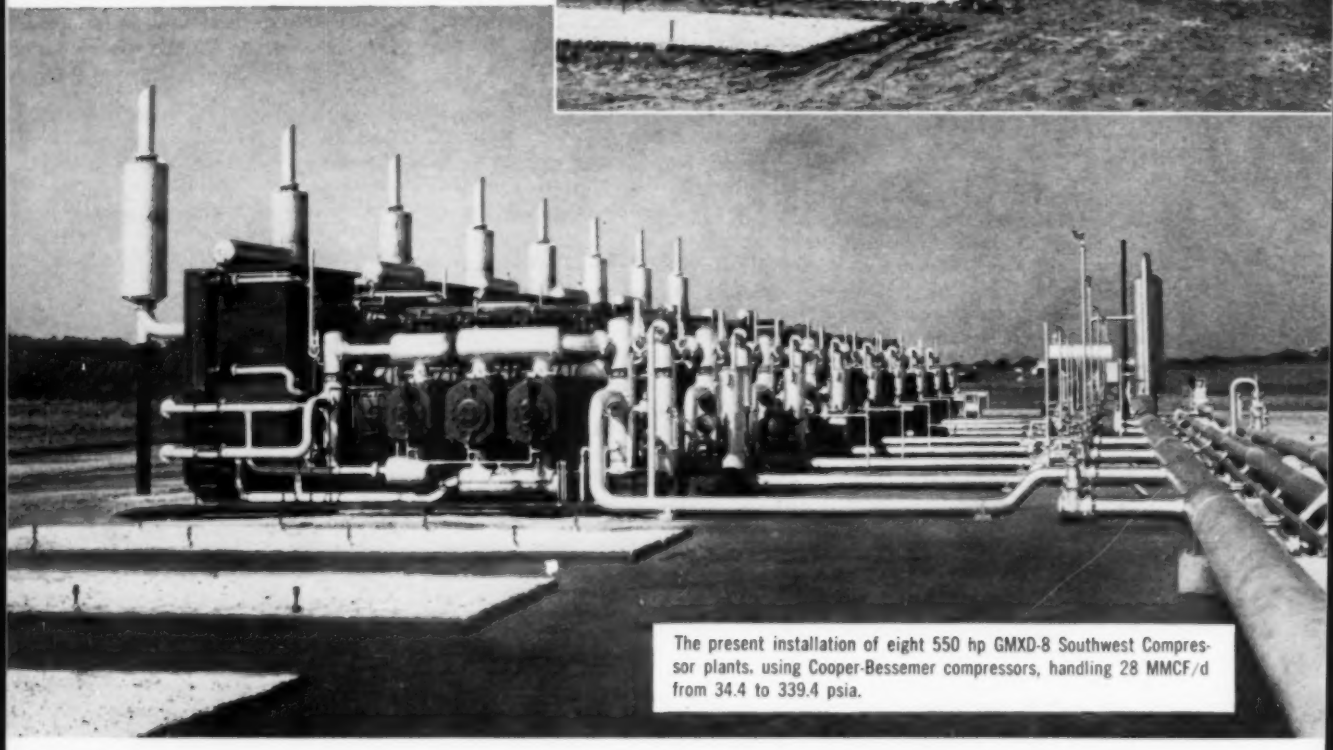

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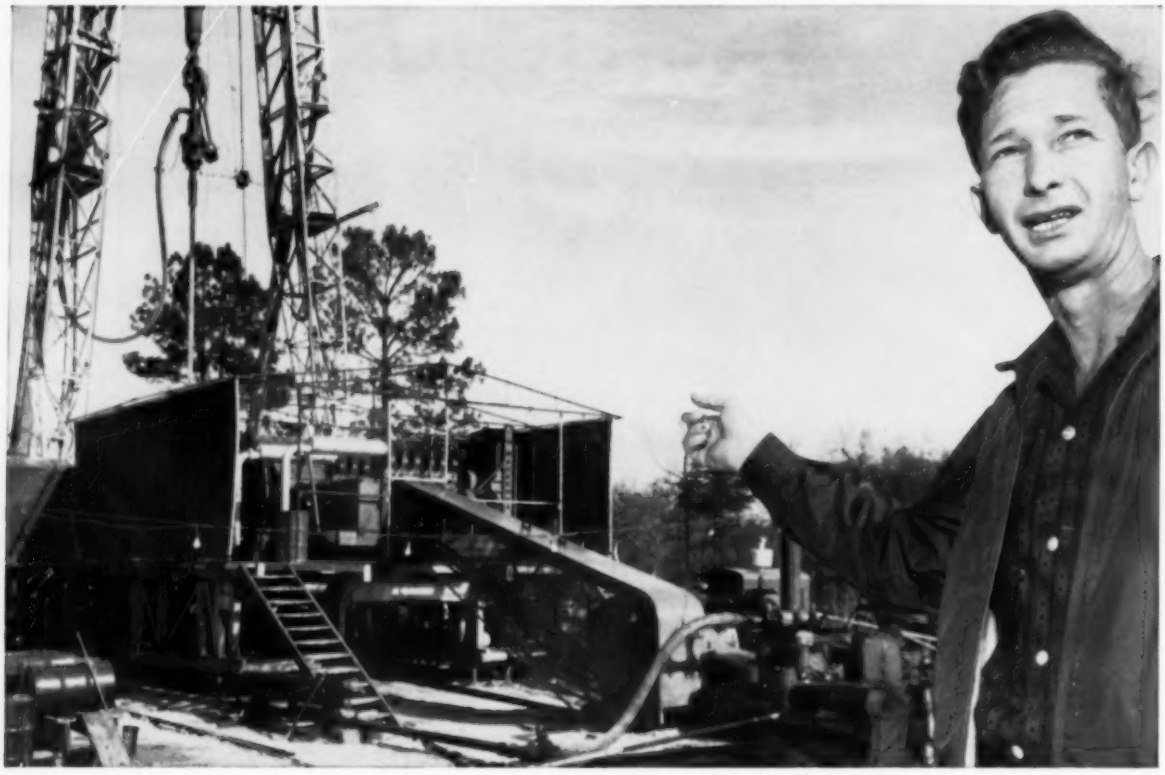

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THE AUTHOR

Jack H. Marsee *is chief engineer for Loffland Brothers Company, Tulsa, Oklahoma. A native of Kansas, Marsee graduated from the University of Oklahoma with a BS degree in mechanical engineering in 1943. Prior to joining Loffland, he was employed as rig superintendent for Phillips Petroleum Company in Odessa, Texas. He joined Loffland as chief engineer in February 1957.*

The Un-Anticipated Trend

When the demand growth failed to develop, a surplus of crude and product stocks made production curtailment necessary to prevent waste and to stabilize the economic structure of the industry. During the first 8 weeks of 1958, domestic production of crude oil average approximately 6,862,000 bbl per day which is only about 52,000 bbl more than the average rate of 1955. If demand had followed the anticipated trend, daily crude production for this period would have been 7,400,000 bbl per day.

Now, the proceeds from production volumes established by demand are the major source of funds to finance petroleum development in this country. Table 1 shows that current rig activity is declining. The established relation[2] of drilling activity to production return supports the conclusion that the decline in number of rigs working and making hole is the result of the current production level being lower than anticipated a year ago.

The reduced volume of drilling and the possibility that this volume shall prevail throughout the coming year is most significant to the economic outlook of the drilling contractor. It has been estimated[2] that 52,134 wells will be drilled in 1958. This is a drop of 1704 wells from the total of 53,838 drilled in 1957.

Also related to the decline in drilling activity is the increasing cost of finding a barrel of oil. A recently published discussion[3] of the future productive capacity and probable reserves of the United States suggests that adverse developments in the factors which determine the "profitability" of drilling may be at least partially responsible for the decline in domestic drilling activity. **"Profitability" in drilling stems from a favorable ratio of cost per barrel found to the price that can be obtained per barrel.**

There has been only one increase in the average price obtained for a barrel of crude during the past four years. On the other hand, all costs for drilling have continued to increase. Prior to the drilling of a well, the operator incurs the cost of exploration and leasing and, when drilling has been accomplished, further cost results from expenses for production of the well. These costs, as well as drilling cost, must be charged against the price that can be obtained for each barrel produced. Figures given in Table 2 were prepared by the API, IPAA, and Mid-Continent Oil and Gas Association to show how these costs were related to production of a net barrel of crude oil during the year shown. **Unfortunately, these are the most recent authoritative figures available but they serve to show that the current economic difficulties of the petroleum-producing industry were brewing far in advance of the present economic recession.**

Table 1.

Date	Rigs Working	Rigs Making Hole (Average for Period)
December 31, 1954	4680	2496
December 31, 1955	4897	2829
December 31, 1956	4885	2549
December 31, 1957	4569	2325
January 6, 1958	—	2182
January 13, 1958	—	2062
January 20, 1958	—	1957
January 27, 1958	—	1861
January 31, 1958	4290	—
February 3, 1958	—	1947
February 10, 1958	—	1982
February 17, 1958	—	1911

Table 2. Estimated Industry Expenditures Per Barrel of Net Crude Production.

	1953	1948	1944
Exploration	$0.56	$0.37	$0.26
Development (mostly drilling)	1.58	1.14	0.78
Production	1.02	0.70	0.43
	$3.16	$2.21	$1.47
Operator's Income from U. S. Petroleum Production.			
Crude oil	$2.68	$2.60	$1.21
Natural gas	0.33	0.16	0.11
Royalty owed	0.15	0.13	0.06
Other	0.01	0.01	0.01
	$3.17	$2.90	$1.39

Facts of Cost Breakdown

Fig. 1 has been drawn to illustrate that each year there is less oil and gas found per foot of hole drilled. Fig. 2 is plotted from information from the AAODC which shows that there has been a continuous rise in the total drilling cost per foot. These figures illustrate that, if drilling cost continues to rise and the volume of oil found continues to decline, a point will be reached where the value of such oil that is found will not be sufficient to recover total cost.

There is plenty of oil yet to be found in the United States, but the possibility that some of the drilling which has been done will not be profitable to the producing companies doing the drilling is sufficient reason for some of the decline in drilling activity. It is reasonable to assume from this that unless price received per barrel of crude is adjusted upward, or unless cost for finding and producing each barrel is reduced, the result will be that the domestic petroleum industry will contribute less and less to the overall demand for petroleum products. Inasmuch as the price of crude is not necessarily related to cost, but rather is determined by demand, the cost factor becomes our only real target. Of course, cost of finding a barrel of oil is affected by many factors. The increasing difficulty of locating productive horizons, the smaller reserves in fields that are found, inflationary trends in all items or services purchased — all are working toward increasing the cost of each barrel found. Included in these costs is that which is paid to the contractor for drilling the wells.

Since 93 percent of all drilling is done on a contract basis, the drilling contracting industry becomes an important segment of the producers' cost. Therefore, any improvement in this segment of cost increases the barrels found per dollar spent, and does in turn

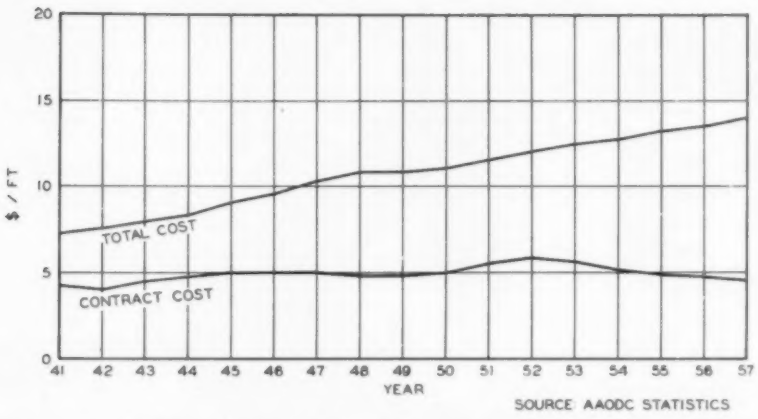


FIG. 2. **Average contract cost has failed to rise in proportion to average total cost per foot. What happens if these trends continue?**

add substantially to the number of wells that can be drilled.

To date, the drilling contractor has made the greatest contribution toward reducing drilling cost. Curves on Fig. 2 show the yearly average footage price paid the drilling contractor and total cost per foot of hole drilled. Contractor's cost averaged 62 percent of the total footage cost in 1935, 52 percent in 1946, and 33 percent in 1957. Expenses which comprise the 67-percent cost between contractor services and total well cost are cost of mud, cement, tubular goods, and logging and completion requirements. This record is proof of the job that the contractor has done in reducing his share of footage cost.

It is important to recognize that these cost savings have been accomplished through one thing alone — reduction of drilling time. What has been done so far, and what can be done in the future, are two different things. Let us take a look at what has been happening to drilling time.

The line showing average drilling time on Fig. 3 indicates that there has been a significant leveling off in the improvement of drilling techniques and equipment. This is demonstrated by the fact that there was no reduction in drilling time in 1954 and 1955, a 2-percent drop in 1956, and no additional reduction in 1957. Continuance of this trend will be costly to the producing companies because drilling-time reduction is the key to reduced contract footage price.

Bidding Geared to Survival

The ratio of rigs available to drilling to be done creates a competitive situation which results in the lowest return to the drilling contractor. Recent growth of this ratio will probably further the practice of bidding on a level of return that is geared more closely to survival than to providing the funds for investment in better equipment, or development of improved techniques. So long as bid price is the only consideration in the awarding of contracts, the drilling industry will probably continue to be limited in its ability to accumulate sufficient funds to purchase better equipment, develop personnel, and engage in engineering research on drilling techniques and equipment. Yet these are the things that the contract drilling industry must do if further reduction of drilling time is to be accomplished.

Operators can give considerably greater assistance to the contractor toward cutting drilling costs. Many companies have already begun to examine existing policies to be sure that those which are outmoded are not creating unnecessary expense.

Cost-Cutting Factors

More information is being given the contractor concerning the area in which he is to work. Knowledge of the geology of an area went into the selection of the well site. When this information is passed on to the contractor it is of value in planning bit programs, and in planning counter-measures for dealing with bore drift and loss of circulation.

Drilling wells on the basis of three or more in a continuous operation will improve the possibility of cost reduction. It is an established fact that crews working in an area do learn to get a hole down faster. No matter how much prior instruction may have been given, they will almost always do better on the second or third well drilled in an area. Other cost reduction gained by multiple-well contracts would result from reduced transportation cost and lower rig-up expense if skidding is possible.

Consideration should be given to rate of penetration in selecting the type of mud to be used in the drilling of a well. It has been established that mud types vary in their ability to assist in obtaining faster penetration rates while maintaining good hole protection. Optimum hydraulics help to offset the effect of a poor rate-or-penetration mud, but this is a second-best procedure. The best rates of penetration are obtained by use of a good hole-making mud *and* good hydraulics.

Deviation limits expressed in terms of maximum-rate change of deviation or direction result in lower drilling cost in instances where the use of oversize drill collars, anti-drift subs, and stabilizers is reasonable. These tools will aid in reducing bore drift, but their principal value is in reducing the rate change of deviation or direction. When these tools are used, bit weight can approach the maximum established by other factors and thus loss in penetration rate, which is normally associated with excessive bore drift, can be minimized. Less stringent requirements concerning deviation will result in lowered cost, as will planning locations to take advantage of the natural drift that takes place in an area.

These are a few of the things that producing companies have in their control which could result in lower drilling cost. Greater effort and cooperation between the contractor and producer in the matter of technological improvements would surely be to their mutual benefit.

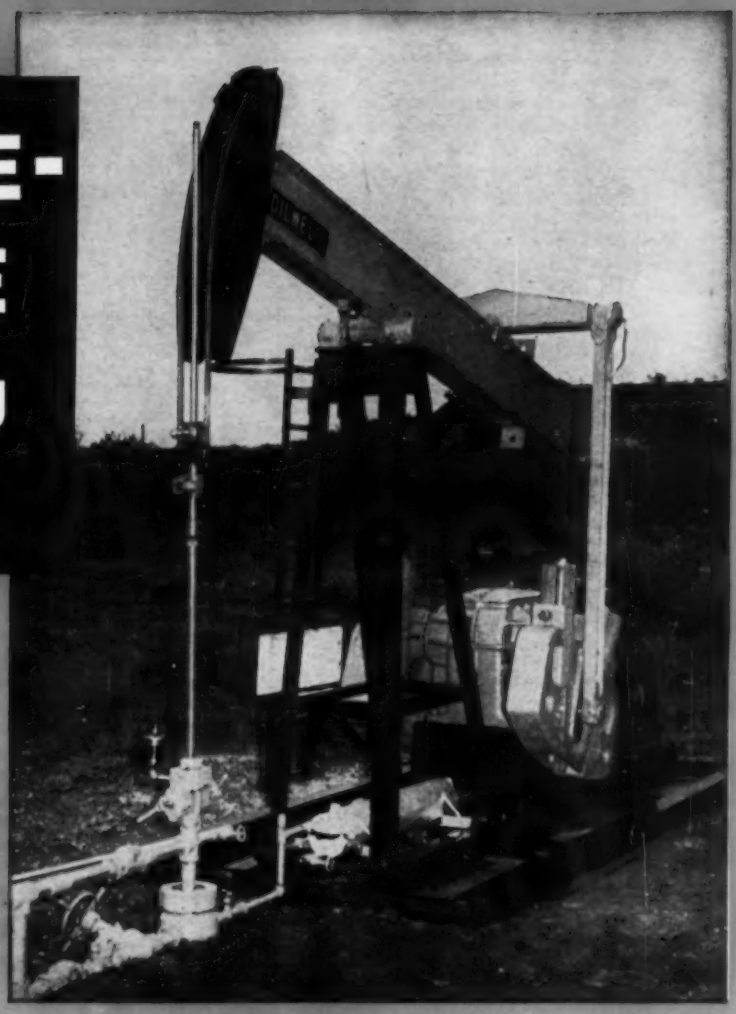
New Tools, Techniques

Technological improvements made to date have contributed significantly to reducing the time required per well; and while this reduction in time was taking place, more wells were drilled each year. The fear that improvements in technology will result in less work for the contractor is not substantiated in the history of contracting business.

Air and gas drilling, the turbodrill, and additives aimed at improving the drilling fluid are developments which show promise of reducing drilling costs by improving the drilling rate.

Drilling with air or gas under favorable circumstances has yielded the only really exciting results of all the drilling innovations that have appeared in the past 10 years. Water entry into the well bore is a principal difficulty encountered in air or gas drilling, and we regard this problem in the same manner as would be the case with loss of circulation in a conventional hole. That is, water entry creates cost that we cannot reasonably estimate, so must be handled on a day-rate basis. There has been some success in sealing water-producing zones by squeezing plastic and

WIDE-BASE Pumping Units . . .



. . . as well as standard-base types are now included in the "Oilwell" line

YOU CAN SAVE the cost of concrete bases by installing "Oilwell" wide-base pumping units in many instances when pumping speeds are not excessive.

Think what this means to lease operators where production is temporary and pumping equipment may be moved from time to time.

The samson post, walking beam, counter-balancing and gear case components of these new units are identical in every respect with corresponding sizes in "Oilwell's" standard line. But the wide box-type base, made of extra-heavy steel girders with welded cross bracing, provides adequate bearing area to support pumping loads where ground conditions are normal, without the need of concrete bases. Just level off the well-site, skid the unit into position, hook up the sucker-rods and your well is ready to go on the pump.

Count ALL the costs before deciding! You'll find that "Oilwell" WIDE-BASE Pumping Units in sizes from 7A7 to 34G21 can often save you money over the conventional types which require the added expense of providing a concrete base.

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PGAC's Sidewall Sampler with the new Hard Formation Core Barrels

For Side Wall Sampling of extremely dense and hard formations from which it was previously considered impossible to obtain cores with a wireline percussion-type sample taker, PGAC developed a new type Hard Formation Core Barrel.

The success of this new hard formation core barrel is due to two factors. First, PGAC engineering devised a means of positioning the core sampling gun in the bore hole so that the projectile barrels have optimum standoff and strike the target squarely—with greater impact. Second, special powder loading, plus careful selection of steel and new processes of heat treatment, combine to produce maximum power behind a barrel which is not damaged upon impact with extremely hard formations.

This new core barrel has enabled PGAC to obtain sidewall samples from formations of extremely high densities and low porosity and permeability. These separately-fired hard formation core barrels obtain up to 32 samples, each 13/16" in diameter and up to 1¾" long, on a single trip in the hole.

PGAC also offers two Standard coring guns, which obtain samples 1 3/16" diam. x 2¼" long, and 13/16" diam. x 1⅜" long.

All three guns operate under foolproof safety features that prevent accidental firing and assure firing by intention only.

Write today for further information

(Right) PGAC's 32-shot Jumbo sidewall coring tool.
(Above) PGAC sidewall coring projectile and cores: A — Cutter; B — Mud extrusion ports; C — Core barrels; D — Powder chamber and retrieving cable housing; E — Large PGAC Jumbo Cores.

PGAC-586

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gelatinous material into the producing formation. Also desiccant and foaming agents have been used to dry and disperse the cuttings so that drilling could continue in the presence of small amounts of water. Up to now, however, the materials and processes used to deal with water entry have been expensive and uncertain. **Perfection of an economical method for sealing fluid entry into a hole being air-drilled would be a really significant step toward reducing drilling costs.**

The turbodrill seems to be both rugged and uncomplicated. This tool generally requires the application of larger-than-normal pumps to develop the tremendous horsepower at the bit that the tool is capable of producing. Thus far, however, no bit has been made which can absorb the horsepower developed by the tool and no means exist to limit its horsepower output. A similar situation exists in conventional practice where less than maximum power is delivered to the bit because it is not capable of absorbing additional power input. When such a bit is developed it should be practical for use with conventional tools as well as the turbodrill. It appears that considerable development work on a bit for the turbodrill will be necessary for it to have a significant part in the economics of drilling.

Improvements in drilling-mud technology must be given credit for much of the gain that has been realized in drilling operations in the past 10 years. A drilling-mud additive which adds life to rock-bit bearings is a recent development. In instances where bit life is shortened by bearing failure, this additive will reduce drilling time per well.

Affording the Cost-Savers

These are the developments which show the greatest promise of reducing the contractor's part of drilling cost. The mud additive mentioned is the only development which does not require additional investment in equipment in order to be used. This is probably representative of the situation concerning new developments, i.e., most improvements in tools or technique will require additional investment.

The contractor's present margin of profit over cost will delay the use of even the most worthwhile tools because there is no room for error when a contractor spends his money for new equipment.

Innovations must be thoroughly evaluated and field-proved before any widespread usage will be given them. This procedure would be commendable under most circumstances, but the industry as a whole needs a cheaper drilling method now. Delay in the development of a cheaper method could be more expensive than a few instances where promising tools or methods fail to provide reduced drilling cost.

Considerable emphasis has been placed on the premise that: **Reduced contractor cost can only result from reduced drilling time.** This premise is supported by the curve on Fig. 3 which shows the trend in contractor's daily operating cost. There is no indication of change in the direction of this trend. The cost curves take on greater meaning if specific items are considered. Since 1952, slush-pump prices have increased from about $42 per hp to about $51 per hp. Since 1955 one of the more popular diesel engines has gone from a price of about $47 per hp to about $57 per hp. But increases in equipment replacement costs as a result of inflation are not the whole story. In order to achieve the reduction in average drilling time that has been achieved, the working requirement of major equipment applied to any particular job has been about doubled. The size of the engines and pumps required is where the greatest change has taken place.

In the early 1950's the rising velocity or annulus flow rate of the drilling mud was not a consideration. Review of our drilling practices in the Rocky Mountain area at that time show that the normal rate was from 125 to 150 ft per min. Current practice calls for rates from 180 to 225 ft per min, especially through the comparatively fast-drilling upper formations. Increasing the flow rate from 150 to 180 ft per min in 8¾-in. hole with 4½-in. drill pipe and 10 lb per gal mud requires a 70 percent increase in the hydraulic horsepower applied. Add the horsepower required for effective use of jet bits, and the result is a pump requirement more than twice that of eight years ago. Any increase in pump requirement necessitates a corresponding increase in engine power. These facts support the statement made earlier that achieving improvements in drilling time require additional funds for investment in better equipment.

The reduced growth of domestic demand for oil and gas is having a significant effect on current drilling activity, but the increase of cost for finding and producing a barrel of oil is the most significant factor in the long-range outlook. **Thus, the domestic drilling and producing industries are faced with a tremendous challenge. More wells must be drilled at less cost if either is to participate in the future progress of the petroleum industry.** Accomplishing this requires a healthy contract drilling industry — an industry capable of making large investments in both physical and human assets. Any approach less far-sighted will result in serious consequences to both the contractor and producer.

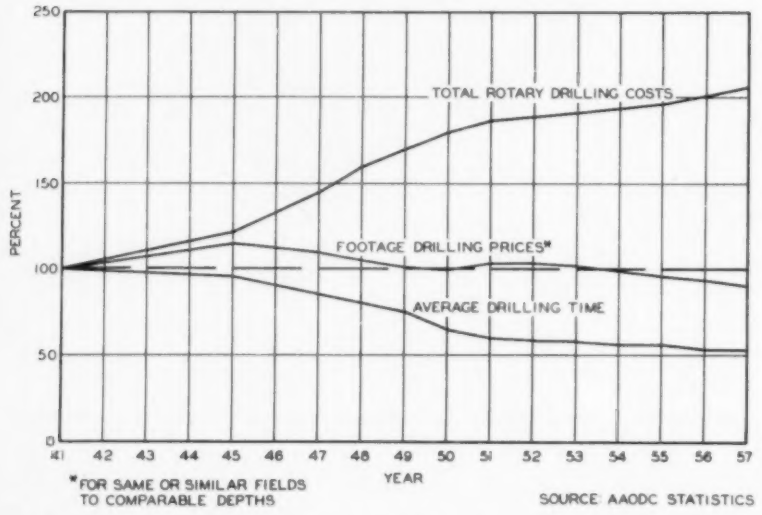

FIG. 3. **Total rotary drilling costs,** footage drilling prices and average drilling time (by year). Note the close correlation of footage prices and drilling time.

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3. Davis, Warren: "A Study of the Future Productive Capacity and Probable Reserves of the United States," *Oil and Gas Journal*, February 24 (1958).

Sources of data: United States Bureau of Mines, American Petroleum Institute, American Gas Association, *Oil and Gas Journal*, *World Oil*, *Petroleum Week*, and *The Petroleum Engineer*.

★ ★ ★

Lease Electrification API Manual Ready Soon

An 18-chapter manual on "Electricity and Lease Electrification" is now in final stages of preparation to supplement the American Petroleum Institute's existing vocational course on Electricity and Electrified Lease Operation. It will also serve to introduce the subject to the field operator — whether or not he enrolls in the course of instruction.

As soon as the manual is published, it will be distributed to all those successfully completing the course and will be made available for sale to the general public through the Petroleum Extension Service, University of Texas at Austin. It is hoped that the manual will be available by fall.

The manual, nearing its final rewriting phase, was compiled and written by a 12-man committee composed of representatives of producing oil companies, electrical equipment manufacturers, electric public service companies and a staff member of the API and the University of Texas. The 18-chapter book, it is believed, will cover very completely the fundamental principles of magnetism, electricity, electric currents and the application of these principles to oilfield equipment. Considerable attention is focused on types of motors, generators, starters, controls and distribution systems used in the oil fields. Two chapters are devoted to the automatic control of lease operations and to automatic custody transfer. The manual will be profusely illustrated and will contain an appendix of useful electrical information and tabular data.

The price of the manual is not yet known, since final number of pages, illustrations, etc., are not definitely established. However, it is estimated that the cost will be between $2 and $3.

This manual is an outgrowth of the highly successful course on Electricity and Electrified Lease Operation, currently being offered by the Petroleum Extension Course of the University of Texas and sponsored by the API.

Objective of both the course and manual is: (1) To increase basic knowledge and fundamentals of electricity and electrical devices, and (2) to increase job efficiency of men in the field who work with or around electrical equipment.

The manual rounds out the API's large set of "tools" for the course, consisting of electrical parts, props, guides and even a working model of a fully electrified and automatic lease.

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The plunger is free-falling, which allows a greater strokes-per-minute rate without being hard on the rods. To compensate for the loose plunger fit, part of the production fluid is directed into the annular space between the barrel tube and the outer traveling tube and used as the sealing medium. H-F 3-Tube pumps are fitted to A.P.I. specifications, including standard balls and seats. Either regular or on-and-off types are available in 2" x 1¼", 2½" x 1¾" and 4" x 3¼" sizes to 25' lengths.

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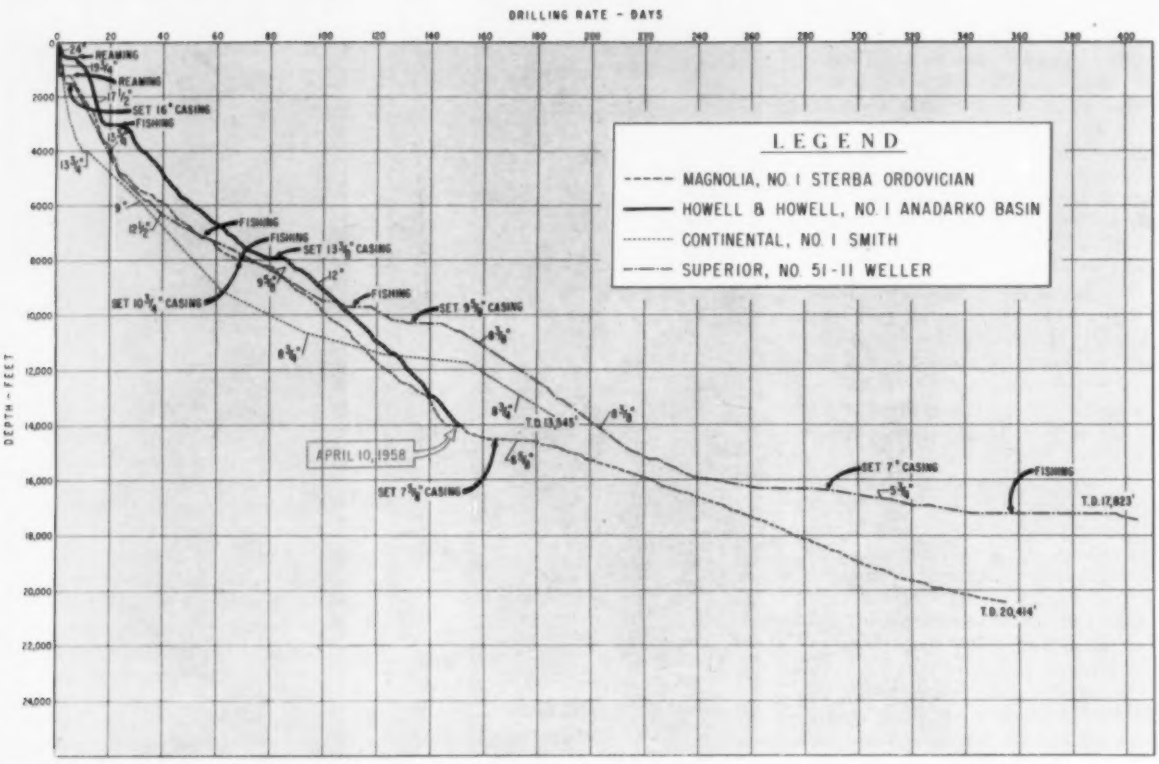
PROGRESS REPORT NO. 2

Anadarko Basin No. 1
Caddo County, Oklahoma



Comparison of drilling rate curves shows Howell & Howell's Anadarko Basin No. 1 passing the rate of the last of three other deep wells drilled in the same general area. On April 10, 1958, the well was drilling at 14,052 ft, 151 days after spud date.

RECORD CONTENDER PASSES HALF-WAY MARK

ON APRIL 10, 1958, drilling passed the 14,000-ft mark in Howell & Howell's Anadarko Basin No. 1, a Caddo County, Oklahoma, super-deep prospect aiming at a total depth of 24,000 ft. *(The Petroleum Engineer,* March 1958, page B-31.)

During the 31 days from March 10 to April 10, the well drilled from 10,991 ft to 14,052 ft, a total of 3061 ft, averaging just under 100 ft per day.

Hole Record

Drilling began in this well on November 10, 1957, with a 24-in. hole drilled to 540 ft. A string of 20-in. OD, 72.16 lb-per-ft line pipe was run and cemented to the surface. A 17½-in. hole was then drilled to 7903 ft and cased with a special string of 13⅜-in. OD, N-80, 85 lb-per-ft casing. Drilling continued with 12-in. hole tentatively scheduled to go to 19,000 ft.

Bit Performance

Very satisfactory performance has been realized from the three-cone roller bits — both regular and jet bits — used in drilling the 12-in. hole. Drilling has been in hard sand and shale, and one bit cut 221 ft in 32½ hr.

The 14-000-ft mark was passed in this well with bit No. 115. As a comparison (see graph above), Magnolia's deep No. 1 Sterba used 144 bits in drilling to 14,000 ft and Superior drilled through this depth with bit No. 178. The Continental No. 1 Smith used 131 bits in drilling to its total depth of 13,545 ft.

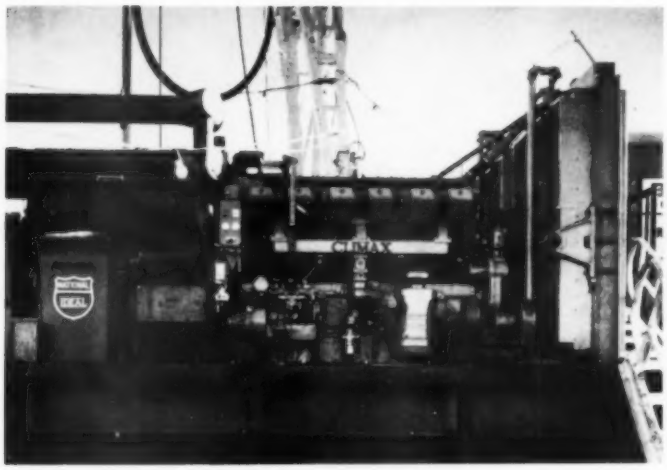
Weight on the bit has varied from 60,000 lb in shale to 85,000 lb in hard sand with rotary-table speed around 45 rpm. A deviation survey on April 9 showed a drift of 1 deg, reduced from a maximum deviation of 1½ deg.

Mud Program

Mud weight has been held at around 11.1 lb per gal, with the diesel oil content increased to 15 percent. Gas zones have been drilled, but instead of weighting-up the mud to stop the gas flow, a de-gasser has been put into service. This will minimize the hazard of lost circulation due to heavier mud.

Two 18-in.-stroke mud pumps are being operated with 5¾-in. liners at around 50 strokes per min, giving a circulation rate of approximately 620 gal per min. Mud velocity in the annulus between the open hole and 5-in. drill pipe is around 120 ft per min. Pump pressures while drilling with jet bits are around 1900 psi.

A densitometer based on the transmission of gamma rays through the flowing mud stream has been installed on the well, giving a continuously recorded measurement of mud density. ★ ★ ★



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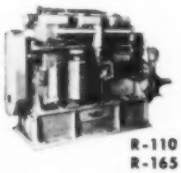
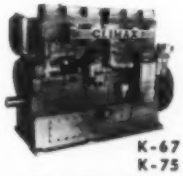
HORSEPOWER RATINGS[1]

Model	No. of Cyls.	Bore and Stroke	Cu. In. Displ.	Pump and Drilling (Continuous Duty)						Hoisting (Intermittent Duty)						
			(2)	600	700	800	900	1000	1100	600	700	800	900	1000	1100	1200
R-110	4	6⅛x7	824	52	62	71	79	86	91	59	70	80	88	96	103	108
R-165	6	6⅛x7	1238	81	93	105	117	127	135	91	105	117	131	143	152	160
K-67	6	7x7	1616	110	129	145	161	176	188	124	145	164	181	197	212	225
K-75	6	7½x7	1855	126	146	166	185	204	218	142	166	187	209	230	245	260
V-80	8	7x7	2155	140	165	188	210	230	246	158	185	211	236	258	277	289
V-85	8	7½x7	2474	164	194	223	246	266	284	184	219	250	278	300	318	333
V-122	12	7x7	3232	217	258	293	324	353	378	244	290	330	364	398	426	442
V-125	12	7½x7	3711	242	292	340	384	417	442	272	328	383	432	469	498	520

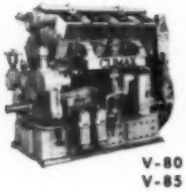
(1) These are continuous duty ratings on standard units that include a radiator and fan.
(2) R.P.M.



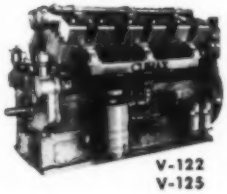
R-110
R-165



K-67
K-75



V-80
V-85



V-122
V-125

Here's Why

1. All models have a 7" stroke.
2. All main and connecting rod bearings are the precision type.
3. All intake and exhaust valves are the free-to-rotate type.
4. All cylinder blocks are provided with renewable sleeves (except R series).
5. All cylinder blocks are cast separate from the crankcase.
6. All pistons are aluminum, cam ground and have five (5) rings.
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9. All cylinder heads have Climax high turbulence type combustion chambers which produce maximum fuel economy.
10. All crankcases and engine bases have large hand holes on each side for easy access to main and connecting rod bearings and the oil pump.
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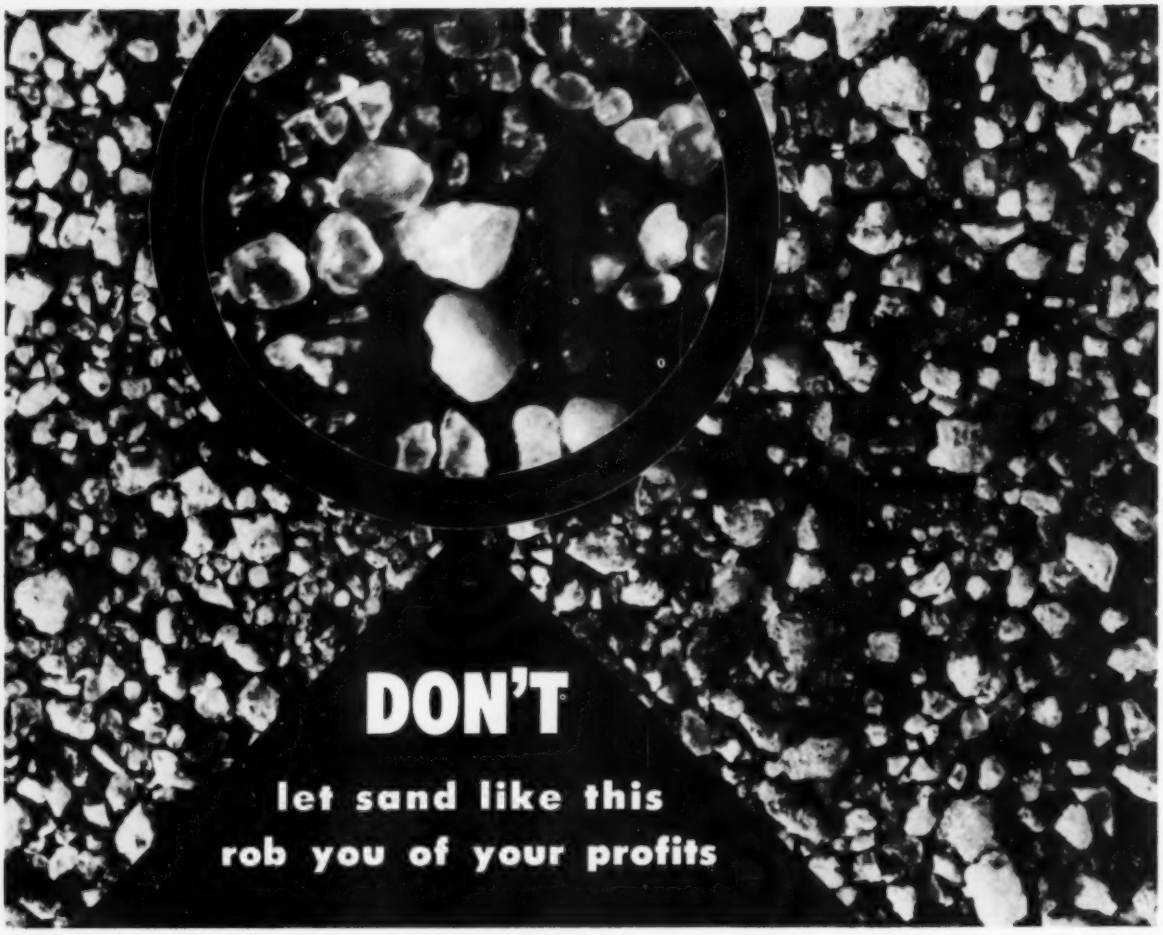


When it gets in your drilling mud, sand like this can eliminate profits.

Glass-hard, it cuts pump parts, bit nozzles, and bit cutters. It increases maintenance costs, decreases bit footage, increases round trips. It increases funnel viscosity, increases mud weight and complicates mud maintenance problems. Generally, it plays hob with drilling costs and profits.

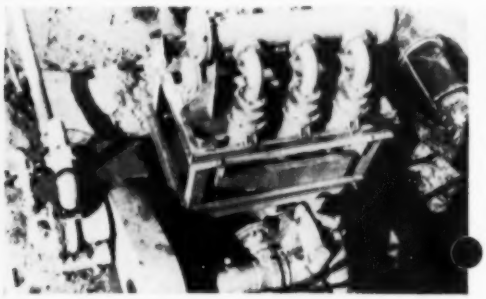
Everybody drilling through sand knows the damage it does, but the big question is how to take the sand out efficiently and economically.

There have been many efforts along this line—most of them only moderately successful.

SWACO and Dorr-Oliver, however, have developed a line of Dorrco D-Sanders that remove virtually all sand and drilled solids larger than 30 or 60 microns.

As a result of efficient performance, these units eliminate problems commonly associated with sand and drilled solids in mud.

Dorrco D-Sanders, distributed by SWACO, can be tailored to virtually any rig or drilling requirement. Write us for further information.

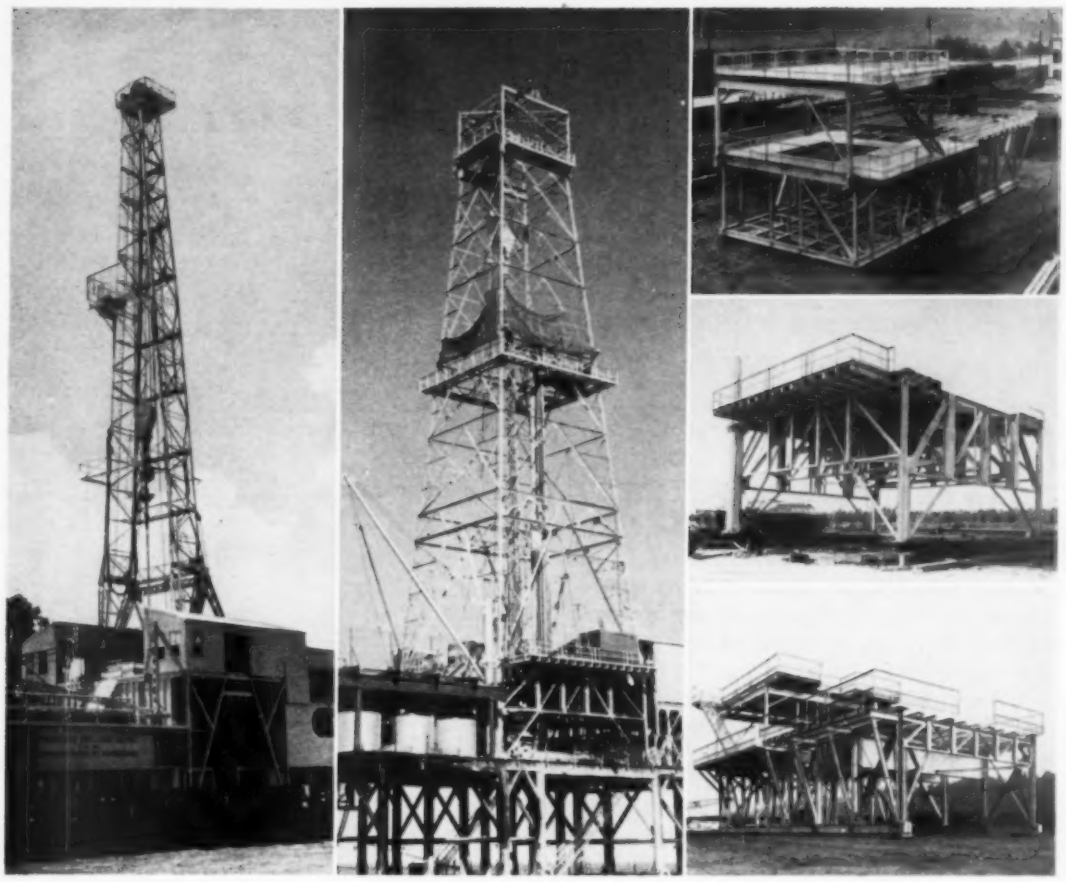


A size 6 D-Sander installed on a well in South Louisiana.

SALT WATER CONTROL Inc.

A Sid Richardson Development Company
1211 Ft. Worth National Bank
Phone: ED 2-4434
Ft. Worth, Texas

SWACO



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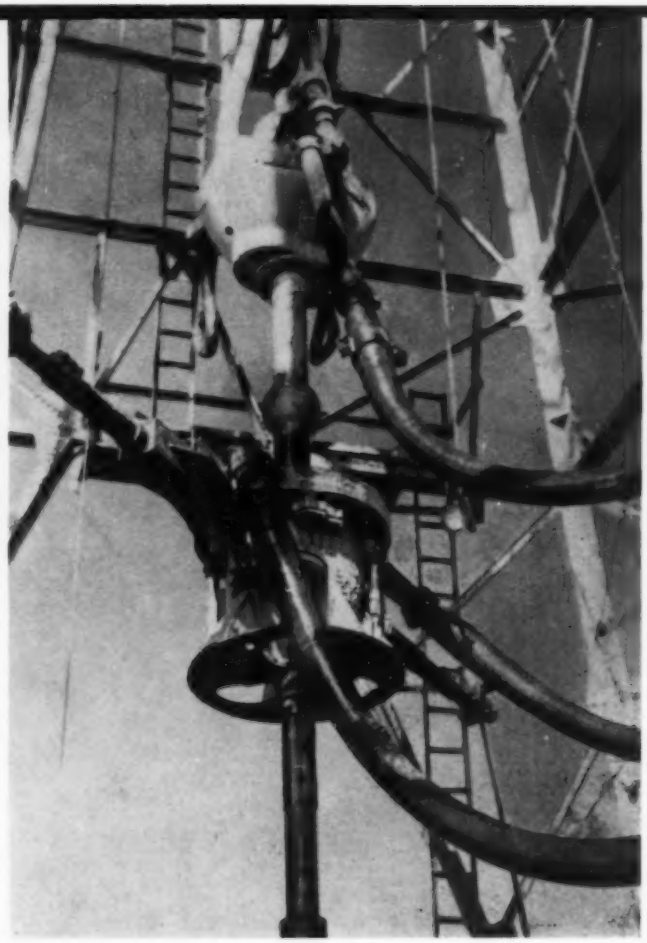
New drilling tool

POWER SWIVEL SPEEDS DRILLING

160-hp unit developed by Baash-Ross tested on 23 wells by Gulf Oil



A NEW DEVICE TO SPEED DRILLING of oil well and construction work bore holes has been developed by the Baash-Ross Division of Joy Manufacturing Company. The device, a rotary power swivel, eliminates the conventional drilling swivel, the kelly, the kelly drive bushing, the rotary table as a rotary device, and the compound chain drive used to rotate the rotary table.

The swivel is a rotating power transmission device which can be attached to the upper end of drill pipe and can be driven hydraulically, electrically or by air. It permits the use of multi-joint stands of drill pipe to reduce the number of connections that must be made on the rig floor. Stands of 60 ft or longer can be connected into the drill string at one time, limited only by the height of the derrick.

Using the longer stands greatly reduces non-drilling time by eliminating one half or two thirds of the time usually consumed in making connections. In addition, it permits the cutting of longer cores as it is not necessary to pick-up from the bore face every thirty feet to make a new connection. As the power swivel is attached to the upper end of the drill string, it permits drilling or reaming up hole as well as drilling down.

Baash-Ross has produced units up to 160 hp which have been tested in the field. Models developed so far have all been hydraulic powered, the hydraulics being furnished by a separate controllable pumping unit and power being transmitted to the swivel through high pressure hoses. However, other equipment now in the development stage is being designed to employ hydraulic, electrical or air power.

Speaking before the Petroleum Group of the South Texas Section of ASME on April 9 in Houston, Hank Morgan, drilling engineer for Gulf Oil Corporation, Morgan City, Louisiana, stated that one power swivel capable of developing 140 rpm was used by Gulf Oil in drilling 23 wells in the Gulf Coast, 22 of which were drilled directionally. At no time was all the torque available from the unit used in the drilling. Tests of the unit amounted to drilling a total of 7711 ft of 20-in., 15-in., and 9⅞-in. hole in a total operating time of 98 hours.

The tests proved that the swivel can be used to make rat-hole connections as well as to make-up and and break-out drill pipe.

Power swivels larger than 160 hp are still in the development stage, and units as large as 600 hp are being considered. One development model has gone through preliminary tests conducted for the Gulf Oil Corporation in their offshore operation in Louisiana. This unit is a power sub, which is distinguished from a power swivel in that it is placed in the drill string immediately below a conventional drilling swivel and does not, in itself, sustain the load of the drill string, being only a rotating device.

The swivels incorporate a load carrying thrust bearing arrangement similar to that used in conventional drilling swivels to support the load of the drill string. Also incorporated into the power swivel is the conventional drilling fluid circulating wash pipe in order that drilling fluids may be pumped through the drill string. Power swivels under development will be capable of drilling to the depths now possible with conventional equipment. They will be large enough to transmit torque and speed to the drill string equal to that of conventional equipment.

Some of the typical uses of the power swivel in the oil industry, aside from primary drilling operations, are those operations incidental to well completion and remedial operations, such as internal cutting of casing or drill pipe, drilling out sand bridges, drilling out cement plugs, drilling out obstructions in casing, deepening of existing well and various fishing and down hole cutting operations. ★ ★ ★

R. V. Higgins
Petroleum Engineer
U. S. Bureau of Mines
Pacific Petroleum Experiment Station
San Francisco, California

and R. L. Pierce
Reservoir Engineer
Long Beach Harbor Department
Long Beach, California

FIG. 1. **Wilmington field** is the largest in the Los Angeles Basin. Gas is being injected in three zones at the eastern end of the field, as indicated.

Faulting, gas by-passing, low gravity and high viscosity oil complicate . . .

GAS INJECTION IN WILMINGTON FIELD

Increased oil recovery obtained by injecting gas into three separate reservoirs at one end of the field; recovery aided by gravity drainage and encroaching edgewater

BECAUSE OF GAS INJECTION into the Upper and Lower Terminal zones in fault block VB and in the Upper Terminal zone in fault block VI in Wilmington field of California, the long term decline in reservoir pressure has leveled off, and in some cases, increased. Since the program was initiated in 1953, gas-oil ratios have followed a similar pattern, resulting in the production of oil with less net gas per barrel of oil. These gains are significant considering the sands of widely varying permeability and low gravity oil with relatively high viscosity.

The Upper and Lower Terminal zones, fault block VB, have been producing oil since 1945 and the Upper Terminal zone, fault block VI, since 1948. Before starting the gas-injection project, the expansion of dissolved gas was the principal mechanism moving the oil to the wells. Gravity drainage and an edgewater drive also have contributed to the movement of the oil to the wells. When the gas injection was begun, the reservoir pressure and the oil production had declined appreciably. Gas injection was started in the Upper and Lower Terminal zones, fault block VB, in May 1953 and in the Upper Terminal zone, fault block VI, in November 1953.

Oil is being produced from all zones during gas injection without any appreciable loss in reservoir pressure as of January 1956. In the Upper and Lower Terminal zones, fault block VB, the rate of decline per well has been arrested. In the Upper Terminal zone, fault block VI, interpretation of the decline rate has been complicated by the completion of many additional wells. In all the Upper and Lower Terminal zones, fault block VB, and the Upper Terminal zone, fault block VI, the net gas-oil ratio has dropped since gas injection and has remained lower than the gas-oil ratio before gas injection. Thus, the volume of gas required to produce one barrel of oil has been reduced. This is one of the criteria for the success of the gas-injection project.

The zones contain thick sands (minimum net, 188 ft) with widely varying permeability. The average gravity of the oil is 20-24 deg API, and the viscosity of the reservoir oil is relatively high compared to oils in many gas-injection projects. These conditions presented serious problems of by-passing of the gas, and the experiences gained from this project and techniques used to prevent by-passing may be used as helpful guides to operators of properties that have comparable reservoir conditions.

General Description

The Wilmington oil field is in the Wilmington area and harbor district of the City of Los Angeles and the harbor district of the City of Long Beach,

Reprinted from Bureau of Mines Report of Investigations 5338.

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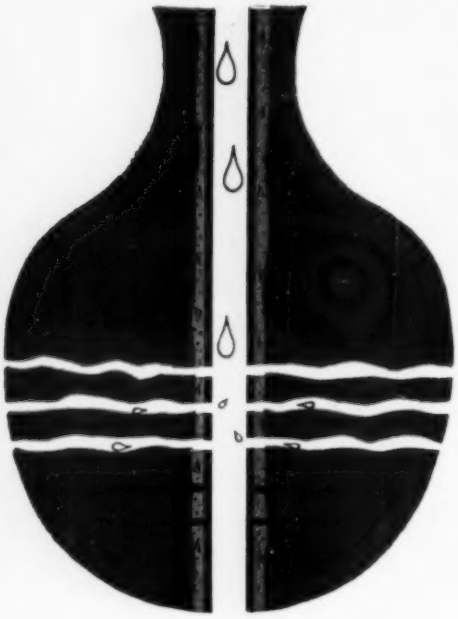

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KEYS TO HELP OPEN LOCKED DEPOSITS OF OIL

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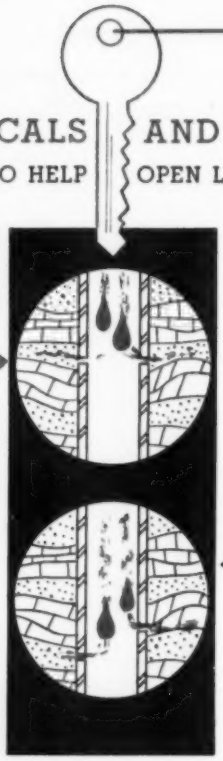
Hydrochloric Acid is most effectively used in the treatment of limestone and dolomite formations to improve permeability. The reaction products are soluble, permitting the removal of the dissolved limestone or dolomite in the spent acid solution. Specific non-emulsifying agents are mixed with the acid, when necessary, to prevent the formation of viscous emulsions.

Hydrochloric Acid is also used as the base fluid of Halliburton Acidfrac and in conjunction with other fracturing services.



HALLIBURTON'S "HV" ACID

Halliburton's "HV" (High Viscosity) Acid inherently delays reaction until the solution is at a greater distance from the well bore, with a resulting larger well drainage area. A comparable volume of Halliburton's "HV" Acid may cover from 4 to 9 times the drainage area of ordinary acid. Extremely useful for temporarily plugging highly permeable sections of well bore in old wells or those previously acidized... which diverts following non-emulsifying acid to other zones... thus opening up new drainage channels.

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HALLIBURTON'S ACID FORMATION CLEANER

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HALLIBURTON'S MCA (Mud Cleanout Agent)

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This versatile, rugged packer can be set again and again for treating different horizons at any point in the well... Proper segregation of the zone to be treated is efficiently accomplished. The "HM" (Hydro-Mechanical) Packer is just one of a wide range of Halliburton packers, research-developed to combine dependable performance, easy operation and time-saving versatility.

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"Fe" Acid is more applicable to treatments in water flooding or disposal wells... used to remove accumulated iron from the water or after acid reaction with rusty pipe, and then deposited at or near the well bore as hydroxides or oxide mixtures... where it reduces the input of water at previous pressures.

"HM" Packer

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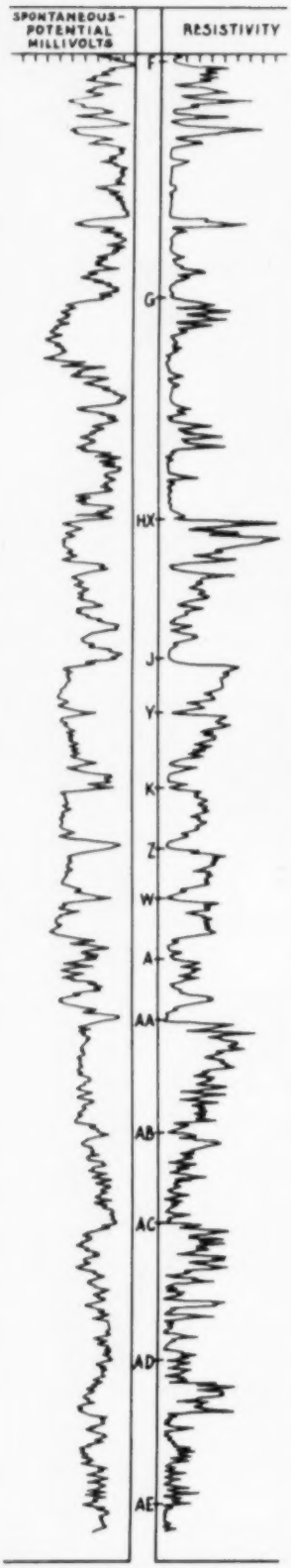

FIG. 2. **Electric log,** typical of those in blocks V and VI, shows seven major sand beds in the Upper Terminal and four in the Lower Terminal.

Los Angeles County. The location of the Wilmington field with respect to other oil fields in the Los Angeles Basin is shown in Fig. 1.

The oil-producing structure is an anticlinal fold with its main axis in a northwesterly and southeasterly direction. The axis is cut by a series of transverse faults, and some of these faults branch into minor ones. Although the faulting may have begun during late Upper Miocene time, probably most of it occurred during the Lower Pliocene time. The strike of the faults is about north and south, and most of the faults head to the east. The vertical displacement of the major faults varies from a maximum of 350 ft at the top of the Terminal zone on the Wilmington fault to about 100 ft on the Allied fault. The subsurface structure is not reflected on the surface owing to the existence of an unconformity at a depth of about 2000 ft. Consequently, subsurface studies have guided the exploration of the field.

The apex of the structure extends to the southeast from beneath the northeastern portion of Terminal Island to an unknown distance beneath the ocean. The southeasterly plunge extends to some point offshore from Seal Beach.

The Wilmington field is badly faulted. The six main fault blocks have been designated by Roman numerals I to VI and the large subfault blocks by the suffix A, B, and D. The fault blocks with which this report is concerned are VB and VI.

The sediments have been laid so prominent markers for the zones and the subzones are present and can be located readily throughout the field by electric logs. The marker for the top of the Tar zone is identified by T; Ranger, F; Upper Terminal, HX; Lower Terminal, AA; Union Pacific, AE; Ford, AO; and "237," BA.

An electric log typical of that measured in blocks VB and VI is shown in Fig. 2. The log shows the seven major sand beds in the Upper Terminal and the four sand bodies in the Lower Terminal. The seven sand bodies in the Upper Terminal are: HX-J, J-Y, Y-K, K-Z, Z-W, W-A, and A-AA; and those for the Lower Terminal are: AA-AB, AB-AC, AC-AD, AD-AE. The edgewater location for each sand body is different. The upper and lower sediments are in the Puente series of Miocene age. The sediments of the Upper Terminal are poorly sorted, loosely consolidated, silty to medium grained sand interbedded with layers of brown silty shales. The degree of consolidation increases with depth.

By-Passing

Owing to the difference in the ability of the several sand bodies in the various pools to transmit fluids, unbalanced injectivity resulted soon after gas injection was begun. Also, the highly permeable streaks in some sand bodies permitted gas to flow through the reservoir sands to the producing wells without recovering oil efficiently. Degree of by-passing was found to vary

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Ralph V. Higgins *is a petroleum engineer with the U. S. Bureau of Mines Pacific Petroleum Expedition Station. He has BS and MS degrees in engineering. After graduation he worked for the Tidewater Oil Company in California for two years and then joined the Bureau of Mines. He is an author and co-author of many articles pertaining to research in petroleum engineering and is a member of the AIME and API.*

R. L. Pierce *is a petroleum engineer of the Long Beach Harbor Department. He attended the University of Southern California graduating with a BS degree in petroleum engineering. He joined the Long Beach Harbor Department in 1949 as a petroleum engineer after two years in hydraulics with the Vapor Recovery Systems, Compton, California. Pierce has been in charge of reservoir engineering for the Long Beach Harbor since 1953, making the supervision of the gas injection program one of his principal duties.*

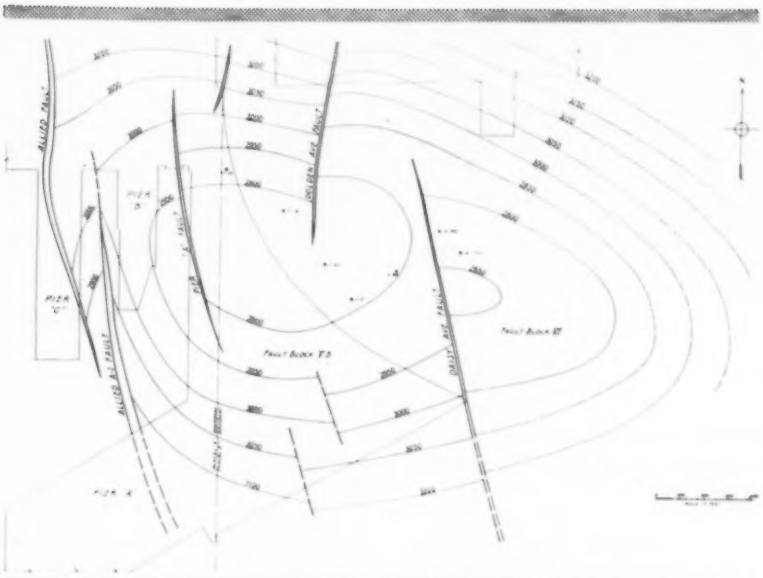

FIG. 3. **Contours on marker HX, Upper Terminal zone,** fault blocks VB and VI. The zone lies mostly under water under piers A and B and the ocean east of pier A. Western boundary is the Allied fault.

widely in the subpools of the injection project, ranging from 0 to 80 percent. In the pools where the by-passing was excessive, a committee composed of the engineering representative from the Long Beach Oil Development Company, Richfield Oil Corporation, and the Long Beach Harbor Department, recommended and instituted remedial measures. These consisted of: (1) Injecting the gas through a "stinger," that is, extending the tubing to the bottom of the well — in some wells the stinger is immersed in oil; (2) injecting oil to selectively plug the more permeable sands; (3) curtailing the oil production from the output wells, to which gas was by-passing, to create a back pressure in the more permeable sands; (4) sealing the highly permeable sands with plastic and cement; (5) increasing the gas-injection rate in sands having the smallest degree of cycling, and (6) using gas-lift valves in the tubing and packers between the casing and the tubing to control the injection rate into the separate sands. The latter was the last method to be tried and proved to have the most merit. Wells J-4 and J-16 were redrilled and completed as injection wells, using these valves. Selective injectivity had been complicated by the use of old oil wells instead of new wells which would have been drilled and completed specifically for use as gas-injection wells.

Plugging Injection Wells

After any sustained shutdown of the injection wells, serious loss of injectivity occurred. Because the gas is very dry, probably the oil is stripped of the lighter fraction leaving a tarry residue that is held aside during the gas injection but flows to the well bore and plugs the sand when gas injection ceases for any length of time.

UPPER TERMINAL ZONE, FAULT BLOCK VB

As gas was injected into three different zones, which are nearly equivalent to three different fields, each zone is treated separately.

The first zone is the Upper Terminal zone, fault block VB. The amount of closure between the apex of the upper HX sand and the edgewater is about 100 ft. For the K sand the closure is 300 ft; for the other sands the closure is within this range. The slope between the 2900 and 3000-ft contours is about 10 ft per 100 ft or 10 percent. This amount of slope is an aid to gravity drainage and probably has contributed to formation of a secondary gas cap.

Reservoir Data

Most of the properties of the reservoir sand and fluids are shown in Table 1. The arithmetical average permeability to air of the pay sand in Upper Terminal zone fault block VB is about 510 md, which is much more conductive than the average oil-producing sand. A permeability of this order would be favorable to gravity drainage. The average initial productivity index was 3.5 bbl per day per psi pressure drop. The edgewater has not been active enough to prevent the loss in pressure of 1450 to 480 psi and formation of a secondary gas cap.

Reservoir Performance and Gas Injection

The first well was completed in the Upper Terminal zone, fault block VB, on July 13, 1945, and the initial production was 320 bbl of clean oil per day with gas-oil ratio 800 through a 28/64-in. choke. From May 1950 to February 1951, 78 wells were completed, and in February 1951, 94 wells were producing oil at a rate of 15,500 bbl per day or 165 bbl per day per well, which was about the highest rate of production obtained from the zone. At the start of gas injection in April 1953, the rate from 100 wells had dropped to 8800 bbl per day or 88 bbl per day per well. The rate continued to drop until five months after gas injection was begun, when the rate "leveled out" at about 6600 bbl per day. The decline in the number of barrels of oil produced per well ceased and leveled out four months after gas injection. Four months after gas injection the number of barrels per day per well remained in the range of 60 to 70 bbl per day per well until January 1, 1956, the last date data were obtained. Thus, the benefits of gas injection are shown because the decline in oil production per well per day was arrested.

Initial reservoir pressure in the zone

Table 1. — Reservoir Data.

	Upper Terminal fault block VB	Lower Terminal fault block VB	Upper Terminal fault block VI
Areal extent, acres	423	381	404
Average thickness of pay, ft	276	187	261
Sand volume, acre ft	116,700	71,600	105,400
Average porosity, percent	33	30	38
Arithmetic average permeability, md	506	266	1,400
Interstitial water, percent	29	37	40
Average oil gravity, API	20.3	24.1	21
Initial datum pressure, psig	1,450	1,670	1,450
Original solution gas-oil ratio, cu ft bbl	170	235	165
Bubble point formation volume factor	1.086	1.123	1.09
Tank oil in place, bbl	196,000,000	93,000,000	170,000,000
Datum depth, vertical subsea, ft	3,300	3,800	3,300
Temperature, F	151	163	151
Viscosity of reservoir oil, centipoises	10.6	4.0	15

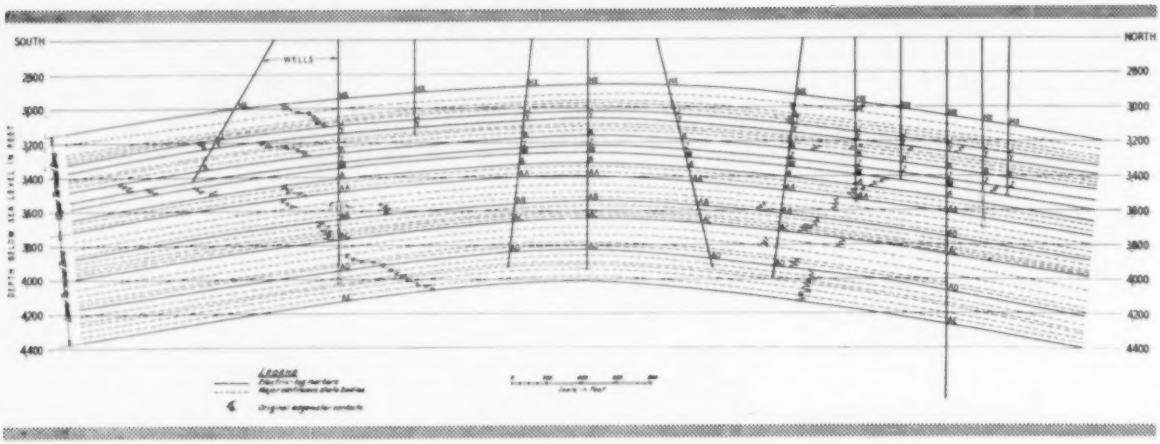

FIG. 4. **North-south section** along Z, Z-1 boundary line, Upper and Lower Terminal zones, fault block VB. Note the differing positions of the edgewater contacts.

at 3300 ft was 1350 psi, and it decreased gradually with the withdrawal of oil. At the start of gas injection the pressure in the HX sand was 630 psi, J-Y sand 530 psi, and K-Z sand 410 psi. Injection of gas into the HX subpool was discontinued August 1954. Large percentages of gas had to be recycled through this sand, and the subpool may have been aided by the injected floodwater coming around the end of the adjoining minor fault. If this were the situation, the gas injection of the HX sand would be unduly credited. As of January 1, 1956, or 2¾ years after gas injection had been undertaken, the pressure in the J-Y sand was 510 psig and K-Z sand 410. The composite pressure was 480 psi. This shows that the withdrawal of 6,430,000 bbl of oil from the HX-AA sand members and 3,680,000 bbl of oil from J-AA did not change the pressure appreciably after gas injection. The improved trend of the weighted average pressure is shown in Fig. 6.

Current gas-oil ratio has the general characteristics in that the peaks in the rate of oil production are followed by peaks in gas-oil ratio. The initial gas-oil ratio of 800 cu ft per bbl increased gradually, except for a peak of 3000 in August 1947; it increased to 2500 in September 1948, then dropped and varied between 800 to 2000 during the following four years. Before gas injection, the decreasing trend of the gas-oil ratio, due in part to shutting in high gas-oil-ratio wells, and the increasing trend of water production with the oil suggests that gravity drainage and the movement of the edgewater have aided recovery.

After gas injection the current gas-oil ratio increased to about 1200, and the net gas-oil ratio averaged about 600 cu ft per bbl, showing that the gas injection had decreased the quantity of net gas required to produce a barrel of oil and therefore was a material aid in recovering oil.

LOWER TERMINAL ZONE, FAULT BLOCK VB

In the Lower Terminal zone, fault block VB, at the eastern end of the Wilmington field, the amount of clos-

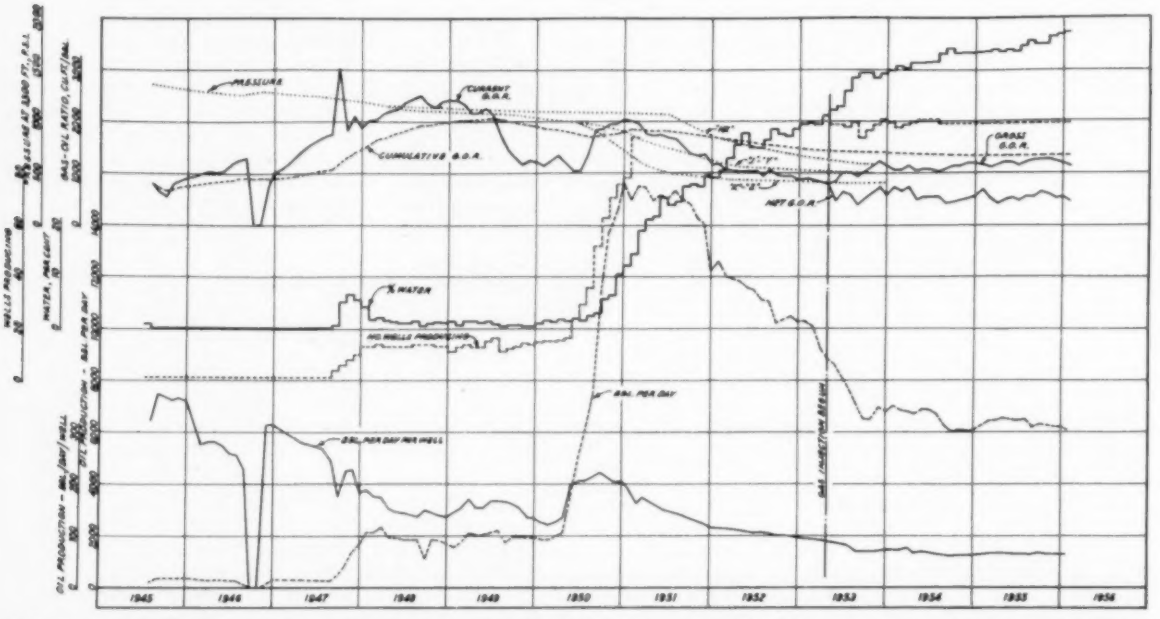

FIG. 5. **Pool performance curves, Upper Terminal zone,** fault block VB. In February 1951, 94 wells were producing oil at the rate of 15,500 bbl per day or 165 bbl per well; at the start of gas injection 8800 bbl of oil per day were being produced from 100 wells, an average of 88 bbl per day.

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The greater penetrating power of McCullough M-3 Bullet Perforators has been proved time after time on jobs like this—penetrating two or even three strings of casing, through thick cement sheaths and deep into the producing formation—getting production or increasing production even after others have failed.

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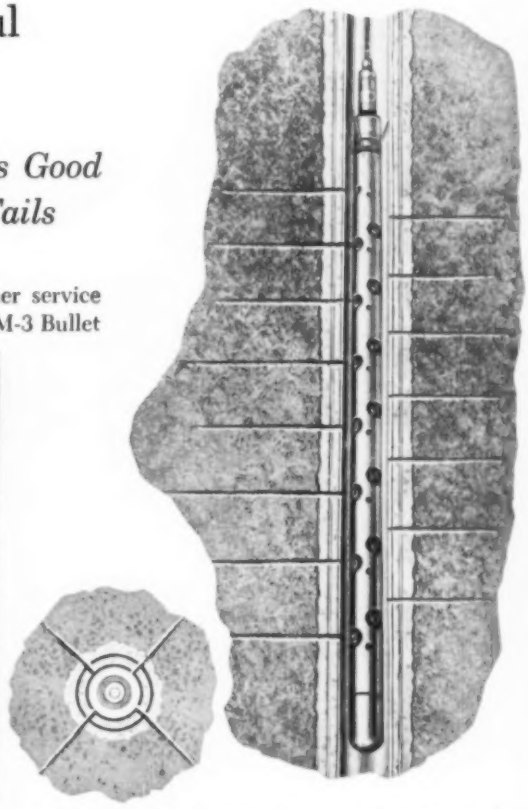
Section of 5" OD casing, unrolled and laid flat to show uniformity of perforation pattern of McCullough M-3, 30-shot Bullet Gun—½" diameter holes, six shots per foot.



McCullough 30-shot M-3 Bullet Perforator. Fires all shots, one to six per foot, at one time. Three or more guns may be connected together and fired on one run.

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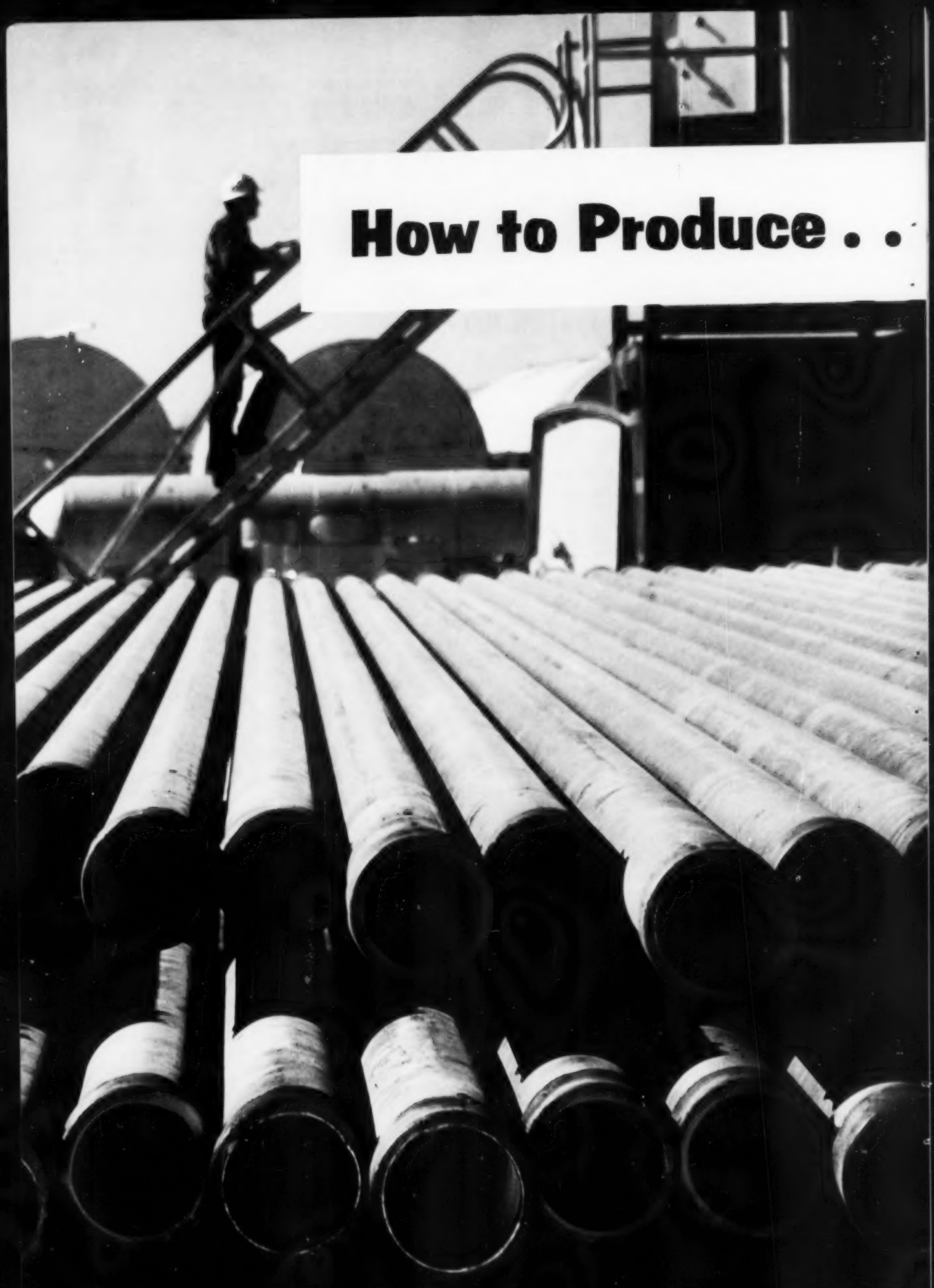
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VALVE TIGHTNESS and what it means to economy-minded management

Valves are one of the most vital components of oil and gas production – no modern operation can be conducted without them.

Valves are costly, yet they generally receive less attention from management than most purchased items. Few users or buyers actually know what is in a valve or how it functions. Many less important items are purchased with much greater deliberation and maintained with greater care, yet few items are more important than valves.

Their most important function is to shut off flow – completely – TIGHT. Yet few valves are actually tight. Most valves do leak – and leakage is expensive – a continuing hidden cost. Frequently, leakage is dangerous. Leakage is never a good thing.

Tightness is the element in valves which tells the story – the one thing for which valves should be specified and purchased – tightness is worth recognizing and worth getting.

Economy is another important element in valves – the initial cost and the maintenance cost must be considered seriously. Far too many valves are purchased for reasons not at all important to those who "pay the bills."

Habit, friendship, shape, size, weight, "easy to turn," "can't be bothered with maintenance," and similar thoughts frequently decide the make and type of valves specified and purchased.

It is time for economy-minded management at all levels to give thought to the many valves now in use, and the many to be purchased and installed in the months and years to come, because valves once installed must be lived with a long, long time, and continuing leakage and excess maintenance costs can take a serious toll from profits.

Although valves may look alike on the outside, they are not alike on the inside, and it is the inside which is most important. Clean, functional simplicity is a fundamental necessity to maintain good working order under the severe conditions in which valves must perform.

Think, for a moment, of the loads imposed. A 2" full opening valve (2 1/16" bore) under only 1000 psi has a gate-to-seat load of 3,404 lbs. This is 1.7 tons. Yet these two parts are moved back and forth against each other in fluids and gases containing contaminants at high velocity and under far from ideal conditions. Under 3000 psi (not uncommon in Christmas tree and flow lines in the fields) a 2" valve carries a load of over 5 tons in *sliding frictional contact* between the sealing surfaces of the gate and the seat!

No wonder that most valves do leak! The higher the pressure the harder it is to prevent leakage.

No one would ever dream of putting a piping system together without "doping" the threads and "gasketing" the flanges. The API Standards set forth steel rings, flange dimensions and specified bolting for various ratings in order to provide safe *tight* joints. These joints are carefully cleaned, and made up tightly. The ring joint gaskets and flange grooves never move in relation to each other, and with reasonable care on assembly they never leak. Yet the same pressure they hold (clean and without movement) is imposed upon valve gates which suffer movement upon seats and are rarely in clean fluid.

It may seem almost impossible to expect valves to be tight under these adverse conditions but this is not the case. McEvoy Valves are tight because they are "gasketed" between the gate and the seat.

A simple system of reservoir, passageway, and seat groove is so arranged that *sealing* compound (*not* grease) is automatically injected between the faces of seat and gate after *each* closing of the valve. This compound forms a leak-proof *gasket* at these mating surfaces so that leakage cannot exist, regardless of conditions of pressure, load of gate on seat, dirt and contaminants, etc.

This is the heart of the McEvoy valve. A system proven by the thousands of McEvoy installations in round-the-world service at all pressures and conditions found in the fields. Hence, tightness – economy is yours at no extra cost.

Maintenance-economy is just as important to the user. This is provided by the reservoir of sealing compound. An extremely small amount of this impervious compound is used each time the valve is operated, and the reservoir contains an uncontaminated supply which lasts from 50 to 150 operations of the valve without renewing (or filling) the reservoirs. Generally these valves require no more than one or two servicings a year. Isn't this a small expense compared to the length of leak-free service rendered?

May we consult with you concerning your valves? We honestly believe we can save you money and provide safer, better operating conditions for you. Let's talk *Tightness* with the attendant economic benefits you can enjoy when you use McEvoy Valves.

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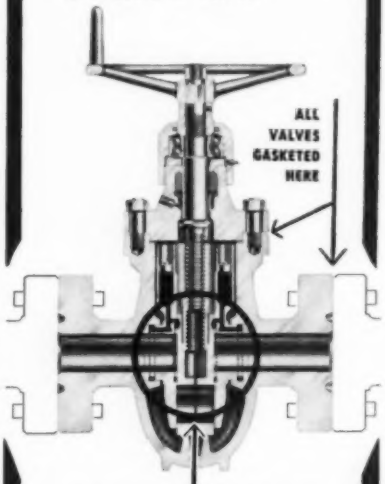
and tightness is important to you

It is common practice to place *gaskets* between flanges, and *"dope"* on threaded connections to provide *tightness* at such joints. There is no movement between these parts, but there *is* movement between gates and seats in valves.



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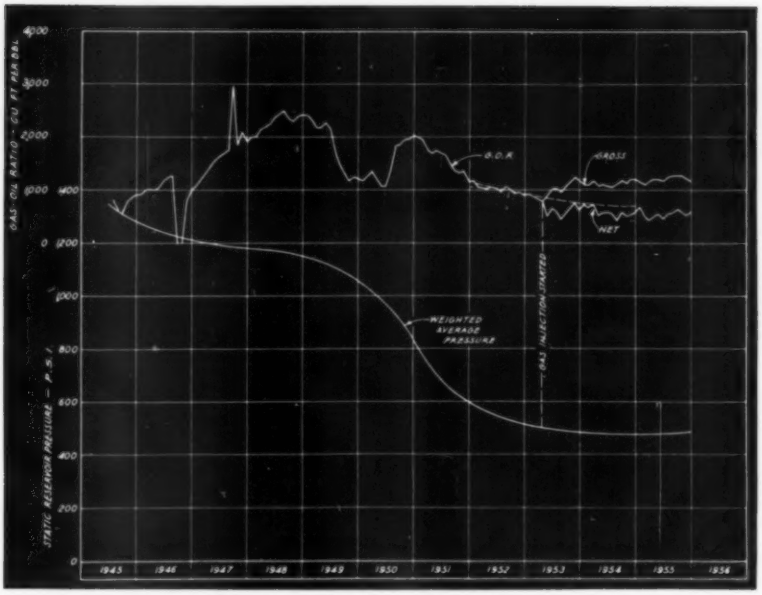

FIG. 6. **Curves showing the effect of gas injection** on pressure and gas-oil ratio, Upper Terminal zone, fault block VB.

ure between the apex of the upper AA sand and the edgewater is about 100 ft, and for the lower AA the closure is about 50 ft. The closure of other sand members varies between 50 and 100 ft. The slope near the apex is less than down the flanks. Average slope on the AA marker is about 8 percent. This amount of slope could aid gravity drainage.

Reservoir Data

Most of the properties of the reservoir sand and fluids are shown in Table 1. The arithmetical average permeability to air of the pay sand is about 266 md, which is conductive enough to aid gravity drainage. The edgewater has not been active enough to prevent the loss in pressure from 1670 psi at the time of discovery to 550 psi just before gas injection. The average initial productivity index was 3.0 bbl of oil per psi pressure drop.

Reservoir Performance and Gas Injection

The first city well was completed in October 1939, and the initial production was 400 bbl of oil per day, with a gas-oil ratio of 1120 cu ft per bbl producing through an 18/64-in. choke. General development of the zone started December 5, 1944, with completion of Well Z1-07. By November 1951, 33 wells had been completed, and the combined production was 5950 bbl per day, the peak rate of oil production from the zone. At that time the daily rate of oil production per well was 180 bbl. By May 1953, the start of gas injection, production from 32 wells had dropped to 4450 bbl of oil per day — a daily production of 139 bbl per well, as is shown in Fig. 8. Four months after gas injection the rate of decline in production established before gas injection had decreased, and the oil production per well leveled out to 90 to 110 bbl per day and remained within this range until January 1, 1956, the last date for which data were obtained. Thus, the benefits of gas injection are indicated by arresting the decline in the daily oil production per well.

The initial pressure in the zone at the datum depth of 3800 ft was 1670 psi, and the pressure decreased gradually with the withdrawal of oil. At the start of gas injection the pressure was 600 psi. The pressure, as of January 1, 1956, 2¾ years after gas injection, was 550 psi. Thus, the withdrawal of 3,515,000 bbl of oil did not materially change the pressure after gas injection.

The weighted average pressure, as is shown in Fig. 9, dropped 50 psi during the withdrawal of the 3,515,000 bbl of oil. This is a small pressure loss compared to the pressure loss prior to gas injection.

The initial gas-oil ratio was 1900 cu ft per bbl as of January 1, 1945, and had increased to 3300 cu ft per bbl by January 1, 1947. The rate then began to decline and within 11 months it was approximately 1500 cu ft per bbl. For five years it remained between 1500 and 1000 until gas injection was begun, when the net gas-oil ratio decreased and remained at an average of about 750 cu ft per bbl for the remainder of the 2¾ years after gas injection, the end of the period for which data have been obtained. The decrease, after gas injection, in the net gas-oil ratio required to produce one barrel of oil shows the material aid to the recovery of oil as a result of gas injection.

UPPER TERMINAL ZONE, FAULT BLOCK VI

The Upper Terminal zone, fault block VI, is in the extreme eastern end of the Wilmington field. The contour

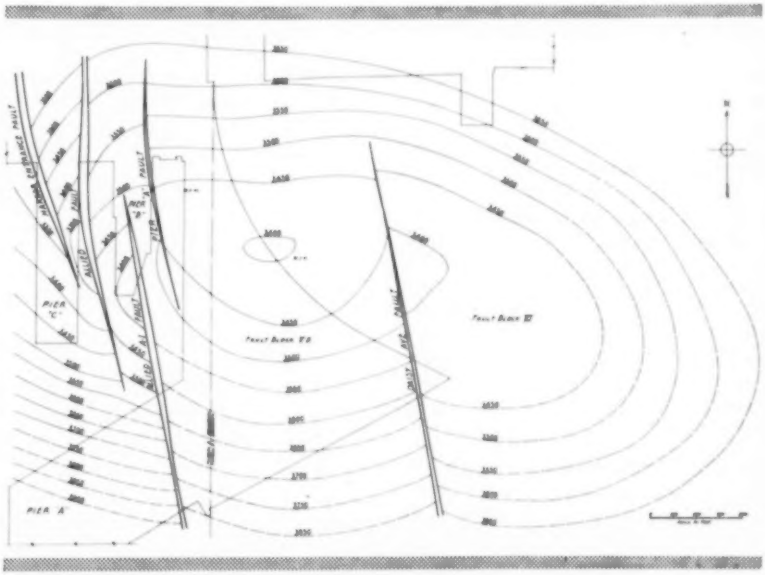

FIG. 7. **Contours on marker AA, Lower Terminal zone,** fault blocks VB and VI. At this marker, there is about 3250 ft between the Daisy Avenue and Allied faults.

FIG. 8. **Pool performance curves, Lower Terminal zone,** fault block VB.

lines show that the zone has the shape of a half dome, with the apex at the middle of the Daisy Avenue fault (Fig. 3). The amount of closure between the apex and the original edgewater contact, as measured on the northeasterly radial line, for the Upper HX and Z sands is 250 ft and for the J, Y, W, A, and Middle HX sands, about 150 ft. The slope of the productive sands is less near the apex than down the flanks.

The slope along the northeasterly radial line between the 2850 and the 2900-ft contours is seven percent and between the 2900 and 2950-ft contours it is 12 percent. Between the 3000 and 3050-ft contours the slope of the sands is 17 percent. This amount of slope is an aid to gravity drainage.

Reservoir Data

Most of the properties of the reservoir sands and fluids are shown in Table 1. The edgewater has not been active enough to prevent the loss of pressure from 1450 psi at the time the first well was drilled to 850, 750, and 600 psi for the sand members HX, J-Y and K-Z-W-A, respectively, just before gas injection. The average initial productivity index was 3.0 bbl of oil per psi pressure drop.

Reservoir Performance and Gas Injection

Since the first well was drilled, the number of completions averaged about four wells per year, and by the time gas injection was begun (November 1953) about six years later, the production from 24 wells was 3600 bbl of oil per day—daily production of 155 bbl of oil per well, as shown in Fig. 10. This rate of production was only 660 bbl per day less than the peak daily production of 4260 bbl per day — a daily production of 162 bbl of oil per well. The peak of 4260 bbl was exceeded after gas injection in June 1955, when the daily production of oil was 4500 bbl per day from 34 wells or a daily production of 135 bbl of oil per well.

Six months after gas injection was begun the declining trend in the daily rate per well "leveled out." This could be due in part to the increased number of producing wells besides the gas injected.

Initial pressure in the zone at the

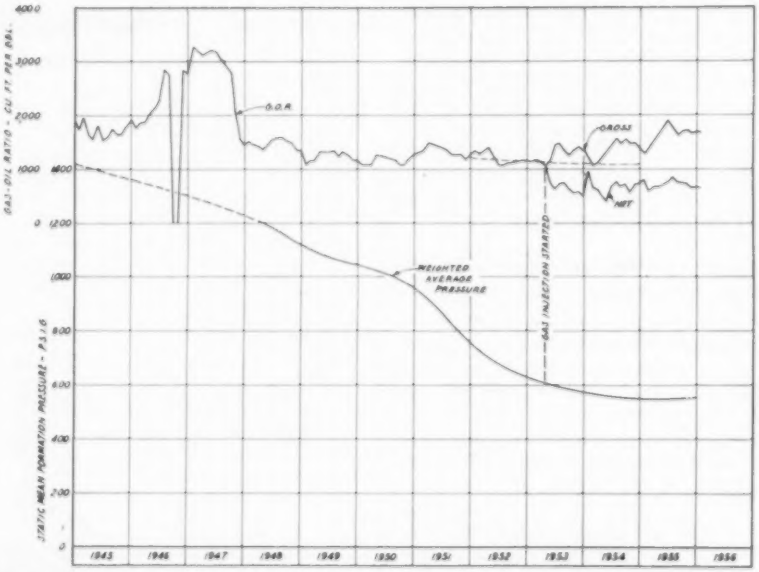

FIG. 9. **Curves showing the effect of gas injection** on pressure and gas-oil ratio, Lower Terminal zone, fault block VB. Only a 50 psi drop was recorded during the withdrawal of 3,515,000 bbl of oil.

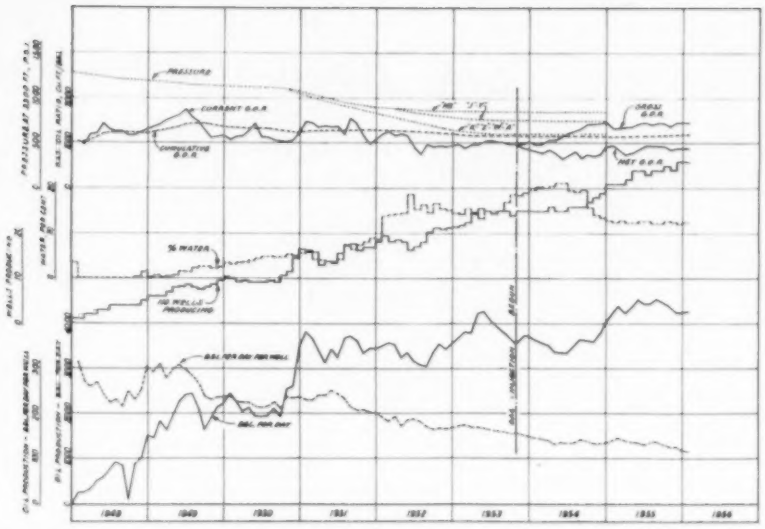

FIG. 10. **Pool performance curves, Upper Terminal zone, fault block VI.**

datum depth of 3300 ft was 1450 psi, and the pressure decreased until the time of gas injection when the pressure was 850 psi in the HX sand; 750 psi in the J and Y sands, and 600 psi in the combined K, Z, W, and A sands.

The initial gas-oil ratio was 1000 cu ft per bbl, and a peak gas-oil ratio of 1700 cu ft per bbl was reached in July 1949, 16 months later. It remained between 1500 to 1000 until July 1952, when it dipped to 800 and then increased to about 900 to 1000 range. At the start of gas injection the gas-oil ratio was 1000 cu ft per bbl and the net gas-oil ratio immediately dropped to and remained less than 1000, thus showing the benefits of gas injection by the production of oil with less net gas per barrel of oil.

Conclusions

Reservoir performance of the three zones (Upper and Lower Terminal in fault block VB, and Upper Terminal, in fault block VI) showed that the gas injection has aided in the recovery of oil. Owing to gas injection, the long-term decline in the reservoir pressure has either leveled off, or the pressure has increased. Since gas injection was initiated, large quantities of oil have been produced from the zones. The small or negative pressure drop per barrel of oil required to produce the large quantity of oil after gas injection shows the benefits of gas injection.

The gas-oil ratio has followed a similar pattern. The net gas-oil ratio remained less than the current gas-oil ratio established before gas injection.

The production curves showing barrels per day per well indicated the benefits of gas injection. The decline in these curves was arrested by gas injection.

Acknowledgment

The authors express their deep appreciation and many thanks to Frank J. Hardesty, chief petroleum engineer, Long Beach Harbor Department, Petroleum Division, Long Beach, California, for his permission to publish the data. ★ ★ ★

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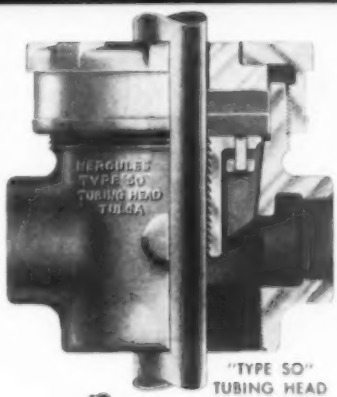

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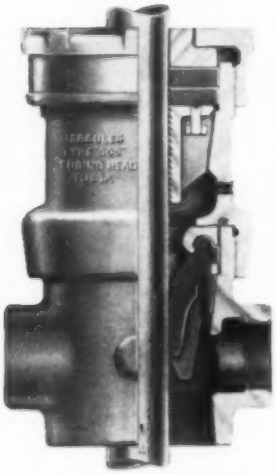

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OIL'S ILLS:

Foreign and Domestic

Myriad problems (not one) call for present adjustments — just don't forget that the oil business "holds as much promise for expansion as before"

Brad Mills, *Executive Vice President,*
American Association of Oilwell Drilling Contractors
Dallas, Texas

THE YEAR 1957 started out with every hope and expectation of being a record one so far as consumption of petroleum products in the United States was concerned.

But as the year progressed it was evident we were in trouble from a combination of causes that tended to make the year one of indecision. The principal producing companies were slow to approach drilling quotas established for the year, while such factors as softening of the general economic picture, reduced consumption of petroleum products, increased expenditures for foreign oil developments, and gradual upward trend in oil imports combined to cloud the optimism displayed at the beginning of the year.

During the late summer and early fall months of 1957 there was still hope that a consumption spurt would give us a two to three percent increase in demand over 1956. However, cold weather was slow in arriving and the general business picture remained somewhat cloudy, resulting in considerably lower oil consumption during the last quarter of 1957 than in 1956.

Several of the foregoing developments would seem rather significant if it were not for the full realization that we are still in a tremendous oil-consumption era with nothing on the horizon to replace oil in any appreciable amount. This is especially significant to all of us because we are in no sense of the word in a serious transitional stage toward the use of other power sources.

Only two years ago we projected into the future a long curve showing the probable trend in total oil demand. This forecast was largely based on the past and indicated that by 1970 we would be using at least 14,000,000 bbl daily in place of the 9,000,000 barrels then currently used. Such an estimate called for the gradual upward annual drilling of wells from 55,000 per year then current to more than 70,000 wells in 1970. The year 1956 was even rosier than we had pictured and a new drilling record for all time was established with 58,500 wells completed. **In 1957 we saw our fondest hopes punctured a bit with the drilling of only 53,500 wells.**

Oil: Here to Stay

In the course of modern history — say the last 200 years — we have seen many great industries come and go. The manufacture and use of steamboats, buggies and trolley cars, tend to remind us that any industry may be a victim of trends, progress and even oblivion. But don't be too alarmed.

The future of oil certainly is more important to all of us than its past. So let us console ourselves with the thought that we are in a vital industry not seriously beset with rivals for its place in the power picture. Oil is not about to pass into oblivion.

Our Drop-in-the-Bucket

Effective petroleum reserves in the United States are around 30,000,000,000 bbl, while that of the rest of the world may be more than 10 times as much. There is a stark fact we have to face and it has a special significance when we look at it squarely.

We may view it as a tremendous threat to our own existence, or we may protect our domestic industry to the point that it will remain the great potential it must be if we continue to protect ourselves toward the determination that no national emergency will catch us wanting.

Imports Importance

To help meet normal petroleum demand with a reasonable quantity of imports is one thing. To create a surplus of petroleum products with increased imports is quite another thing.

Based on a timely address by Mr. Mills titled "Oil — What Has Happened To It?," given March 12, 1958, at the University of Oklahoma, Norman, Oklahoma.

Essentially this has been happening in the United States on a gradual scale since the early part of 1956, especially in the case of California.

We cannot truthfully say that imports alone have been responsible for the general decline in the United States petroleum market picture. But we do know that continuation of imports on an upward or even constant basis is questionable where it is necessary to effect sharp cutbacks in our own production.

Drilling operations decline as the health and general stability of the total petroleum industry declines. This impact is normal and even severe as a surplus of crude oil develops. We sincerely feel that it is not wise to fool ourselves about the necessity for developing adequate oil reserves of our own.

The complexity of our present domestic oil situation in relation to the world output is one we cannot afford to overlook. Many large American producing companies are also large producers and marketers of foreign oil. In some cases the current interest of several American producing companies seems to transcend that of its United States development. This represents a tremendous departure from a period of 20 years ago when these same operators were producing nearly all of their oil in the United States.

It is the absolute right of every American oil company to produce petroleum in any part of the world and in any quantities. But first of all we must be frank and realistic in recognizing the fact that the rest of the world has much more oil in reserve than the United States. Under such conditions, foreign oil naturally supplies most of the foreign needs and may start backing up on us in flood proportions if we do not exercise sensible and reasonable restraints.

Domestic Dilemma

In returning appropriately to our own domestic ills, it appears that certain inequities exist both locally and between the oil producing states. **Selective buying is hurting in many localities,** where new production is having a very hard time finding a market in opposition to old established wellhead outlets. It is extremely difficult, however, to determine the relative rights of new and old producers in areas where the latter have been supplying oil on contract for many years. It is also equally difficult to know how far to "move over" to allow new production a place in the picture when enough oil already is available. This development has been discouraging to prospective operators who fear for marketing of additional reserves, and the result has been reduced drilling operations in many regions.

Regulation of crude oil production varies sharply from state to state, and this fact has resulted in the tendency of a few states to hold the line much better than others in the face of an oil surplus. Conversely, some of the new oil producing states have been finding it difficult to get a market for oil as it comes into the overall picture. Just how far the older producing states will go toward recognizing suggested quotas of the newer producing states remains somewhat of a question mark.

Finger-pointing and counter statements are not the best way out of a weakened producing and drilling picture in the United States. It will require sane appraisal of the causes and probable effects of a lowered oil demand. In simple words, this means that we must adjust ourselves in all departments to a production, drilling and marketing situation that will pass us through a decline that was not anticipated.

Under Consumption

The lower gasoline demand has been rather puzzling in spots and difficult to pinpoint. **Consumption during the past 14 months has been reduced by a tendency of auto owners to do less driving.** We know that vacation and business travel were at least five percent less last year than anticipated. Even the national inclination of 50,000,000 car owners to reduce travel here and there is enough to make itself felt quickly.

Over Production

In any commodity market surpluses are hardest to handle. **Where the law of supply and demand is in evidence, overproduction almost immediately plays havoc with price structure.** It then becomes incumbent on any industry to produce fairly well in line with demand if it is to expect a reasonable price for its products. Stocks of such oil commodities as crude, gasoline and heavier products are sharply up since January 1, 1957. Too much oil on top of the ground can pose a threat to industry stability.

Natural Gas

We know that natural gas has replaced a large amount of fuel oil in several regions, and this has reduced the demand for the latter. However, in the strict sense of the word gas is a petroleum product and must be developed in a manner similar to crude oil. This actually means that one type of petroleum product has been replacing another.

Suez Delusion

During the latter part of 1956 we were in a great frenzy to supply Europe with oil following the Suez incident. We almost groaned and grunted while trying to meet this rapid and unexpected demand from our own reserves.

In the process of meeting European demand our own production spurted upward and gave us a false sense of long-range demand, where at the best we should have retained our perspective. Obviously a sharp cutback was in order and we undoubtedly were too slow in meeting day-to-day requirements after Suez again became operative.

When the economy structure became a bit weaker in early 1957, we undoubtedly underestimated its effect on petroleum demand. Although we certainly cannot say we have been through a depression in any sense of the word, uncertainties in various quarters did combine to lower petroleum production.

Heavy Refinery Runs

It would hardly be fair to blame heavy refinery runs for our various surpluses. Certainly refineries were in a way responsible for stocks in certain commodities, but they were only geared to operate with production and markets that did not quite materialize.

"Perfidiousness"

The threat of price reductions in crude oil has had a serious impact on drilling operations. It is difficult for any producing company to look far into the future when immediate problems beset them. The result is a tendency to discontinue such drilling operations as normally and ultimately will be required.

Net Result

When we sum up the various reasons why the petroleum industry has failed to meet expectations, we have a combination of circumstances responsible for the decline. Opinions differ sharply on which factor is most significant in a chain of circumstances that have given us our present weakened position.

All of us will find it difficult to adjust ourselves and our businesses to lower consumption and development programs that we so fondly predicted two years ago. However, we should resign ourselves to the fact that the future still holds as much promise as before for expansion of petroleum usage, and that those of us who have cast our lot in the industry in one way or another will have to meet whatever the future holds. ★ ★ ★

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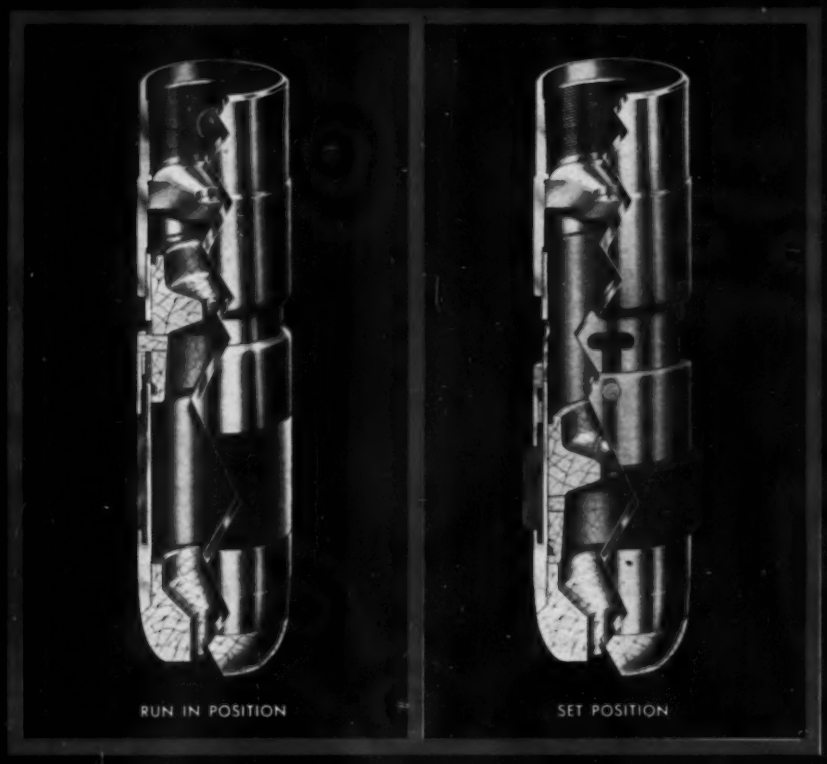

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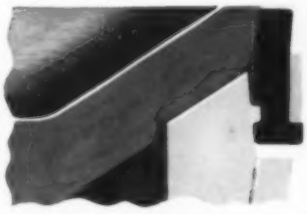

With wear, the entire inclined striking surface of the seat is worn away. An opening can't form next to the seal ring. Both valve and seat wear longer before they need be replaced and seal ring life is increased substantially—

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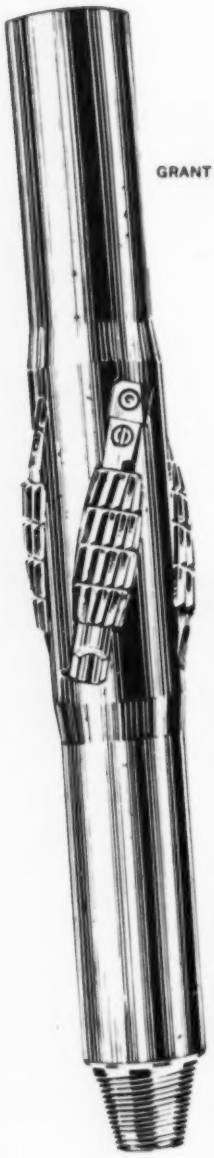

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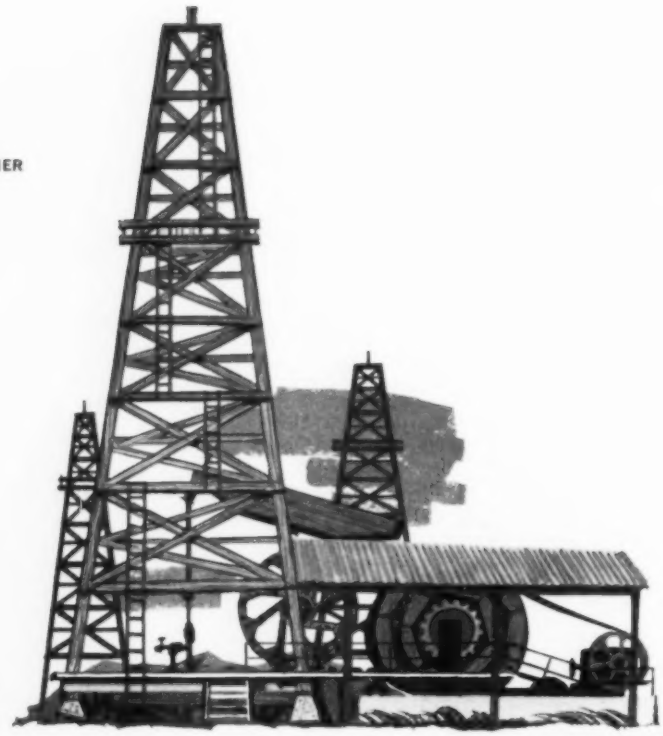

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Rocky Mountain API . . .

OILMEN PONDER PUBLIC, SOCIAL DUTIES

Future demand for Rocky Mountain oil, the industry's public relations, the outlook for drilling contractors and the social responsibility of business are some of the general topics that occupied the attention of more than 600 regional oilmen attending the annual spring meeting of the Rocky Mountain district of the API's Division of Production. The group, assembled from Colorado, New Mexico, Utah, Wyoming, Montana, North Dakota, and Canada met in Denver, Colorado, April 21-23.

Both the Cosmopolitan and Brown Palace hotels were headquarters for the meeting. By special arrangement the Centre Theatre, Denver's newest, was secured for the general sessions.

On Monday, April 21, standing committees of the district were in session throughout the day. General sessions began on Tuesday. Condon MacKay, director of public relations, Carter Oil Company, Tulsa, led off general session speakers. His topic was "How Can We Improve Our Public Relations?"

Dr. Harry Seligson of the Denver University College of Business discussed "Business Responsibility to Society" at the Tuesday morning session. Also at this session D. L. Connelly, API vice president for production and senior vice president of Warren Petroleum Corporation, Houston, presented citations for service to two outstanding members of the Rocky Mountain District. These were made to R. W. Gemmer, Carter Oil Company, Billings, and Walter Forbes, Daniels Insurance Company, Casper.

The Tuesday morning session was concluded by an address by E. E. Monteith, Jr., vice president of the Republic National Bank, Dallas. His subject was "Demand for Crude Oil and How it Will Affect Future Production From the Rocky Mountain Region."

Because of current problems of oversupply and restricted production Monteith's topic was of especial interest. However, Rocky Mountain oil producers have enjoyed relatively stable markets compared to some areas of the country where production has been sharply cut back. Regional oilmen have just completed drilling more wells in the first three months of 1958 than in any other first quarter in history. Monteith's discussion put the optimistic Rocky Mountain region outlook into long range industry perspective.

The Tuesday afternoon group session featured election of new officers for the district. In addition, Jack Marsee, Loffiand Brothers Company, Tulsa, discussed "Economic Outlook for the Drilling Contractor" . . . another topic of much regional interest, since the Rocky Mountain states are at the present time one of the best of the nation's areas of contractor operation.

Wednesday sessions featured technical papers on various production problems.

Entertainment and social features of the convention included a buffet at the Denver Petroleum Club on Monday evening, a luncheon and style show for the ladies at the Petroleum Club Tuesday and a dance Wednesday evening.

The session is the second meeting of the district to be held in Denver. The 1957 session was held in Casper.

George Goodin, Petroleum Information, Casper, is district chairman. Gene L. Weger, Sinclair Oil & Gas, Denver, is chairman of the general arrangements committee.

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EXPLORATION ACTIVITIES

LIBYA

Pan American Awarded 23,000,000-Acre Concession

Concessions in Libya totaling nearly 23,000,000 acres have been awarded to Pan American Petroleum Corporation by the Libyan Petroleum Commission. They are being assigned to a newly-formed company, Pan American Libya Oil Company.

Three tracts — one in Zone III and two in Zone IV – comprise the new concessions. Tract 76, a square area of 9,202,498 acres, is in Zone III, its western boundary coinciding with the western boundary of the zone. It is about 285 miles south of the Mediterranean seacoast at the point where the Gulf of Sidra indents the North African shoreline.

Tract 75, largest of the three, lies in the Fezzan Basin, approximately 500 miles south of Tripoli and 190 miles southeast of the Atshan discovery in Tract 1, which lies along Libya's western border. Tract 75 contains 11,049,-324 acres, and is in Zone IV.

Tract 74, consisting of 2,705,745 acres, lies about 330 miles southeast of Tripoli and 160 miles to the northeast of Atshan. It is on the northeast edge of the Fezzan Basin, and lies along the northern edge of Zone IV.

ALBERTA

Kerr-McGee Hits Gas

A gas discovery on a 24,000-acre block 90 miles north of Calgary marks the entry of Kerr-McGee Oil Industries, Inc., Oklahoma City, into the production of oil and gas in Canada.

The first well drilled by Kerr-McGee in Canada is Sylvan Lake 11-20-39-1 in C SE NW Sec. 20, T39N, R1W of 5th Meridian, Alberta, flowing gas from two zones with a total net porosity of 57 ft.

Well was perforated and completed in the Pekisko member of the Mississippian, at intervals of 6589-6609 ft and 6670-6690 ft. The upper portion has 31 ft of microlog porosity; the lower portion 26 ft.

Absolute open flow is estimated at 16,000,000 cu ft per day. On the first drillstem test during the drilling process the well was flowed 60 minutes from the 6601-44 ft interval, gas to the surface in eight minutes, flowing at the rate of 2,740,000 cu ft per day. On the second drillstem test, the well flowed at the rate of 4,070,000 cu ft per day through a 10/64-in. choke, after 45 minutes testing from 6668-6758 ft, gas to the surface in two minutes.

WEST AFRICA

Jersey Standard to Explore In Portuguese Guinea

Standard Oil Company (New Jersey) has signed an agreement with the Portuguese government to spend a minimum of $7,000,000 over a five-year period for oil exploration and development in Portuguese Guinea.

A new Jersey affiliate, Esso Exploration Guine, Inc., carry out the exploration work in an 11,000,000 acre concession on mainland and offshore areas of Portuguese Guinea.

UTAH

Important Aneth Area Find

Continental Oil Company's No. 1 Federal-Miller, 13 miles northwest of the Aneth field in San Juan County, is shaping up as one of the significant new finds of the year. The well, bottomed at 6510, yielded 360 ft of oil and 160 ft of heavily gas and oil-cut mud on a two-hour drillstem test. On the test, at 6285 to 6316 ft, the tool plugged but flowing pressure reached 1355 psi.

On previous test of the Paradox, perforated at 6294-324 ft, Conoco's well was swabbed of 4 bbl of oil in 5 hours. Earlier, after acidizing, the well flowed 10 bbl of oil, then was swabbed 120 bbl of oil with no acid water.

Casing has been run to 6506 ft. Top of the Paradox was called at 6095 ft. The indicated discovery is three miles from any previous drilling.

NEW MEXICO

Gallup Zone Opener in NW

W. R. Weaver No. 1 McAdams has opened new Gallup zone gas-condensate production in the Fulcher-Kutz Canyon field, San Juan County. Regular pay in the field is the Pictured Cliffs.

The No. 1 McAdams was completed with a potential of 9,010,000 cu ft of gas and 72 bbl of condensate per day through a ¾-in. choke. The Gallup was topped at 5913 ft. Total depth of the well was 6289 ft. Perforations in the Gallup zone were at 6106-40 and 6237-84 ft.

Rank Test in Guadalupe County

Cities Service Oil Company has scheduled a rank wildcat in the east central part of the state. The company has staked its Driggers No. 1 in Guadalupe County, 16 miles north of Santa Rosa. It is scheduled to be a 6100 ft Pennsylvanian test. It spots 1980 ft from the north line and 1980 ft from the east line of Sec. 22-11N-21E.

PUERTO RICO

Exploration Permits to Houston Man

David L. Gordon, president of Maritime Oil Company, Houston, Texas, has negotiated an exploration agreement on more than 200,000 acres of the island for his firm and associates.

The grant includes an exploration permit and lease-selection option covering a land and offshore area on the southern coast of the island. Approximately 50,000 acres in lease properties in the 200,000 acre area may be selected each year.

Gordon's agreement with the Puerto Rican Mining Commission authorizes transfer of the permit rights to Maritime Oil Company or to a corporation to be organized especially to develop the property.

PAKISTAN

Government Takes Working Interest with Tidewater, Skelly, Kewanee

Tidewater Oil Company, Skelly Oil Company and Kewanee Oil Company have signed a concession agreement with the government of Pakistan to conduct exploration in two areas totaling 10,000 sq miles in West Pakistan.

Skelly and Kewanee are equal partners with Tidewater in the venture with Tidewater as operator. The Government of Pakistan will also become a 25 percent working partner in the venture assuming a proportionate share of the risk.

Under Pakistani law production royalties and taxes paid to the government amount to 50 percent of the ventures' profit.

OREGON

10,000 Ft Bear Creek Test

Drilling of an exploratory well on the 159,000-acre Bear Creek Anticline tract of Crook County, Oregon, will be undertaken shortly, Standard Oil Company of California, Western Operations, Inc., has disclosed.

Standard, principal leaseholder in the area, said the new well will be drilled to a depth of 10,000 ft by Sunray Mid-Continent Oil Company on behalf of the two firms and Sunray's partners in the venture, Lloyd Corporation, Ltd. and McCulloch Oil Exploration Company of California, Inc.

Site of the wildcat, to be known as "Sunray Mid-Continent Oil Company, Operator, Standard-Lloyd-McCulloch Bear Creek Unit No. 1," will be southeast of the town of Prineville.

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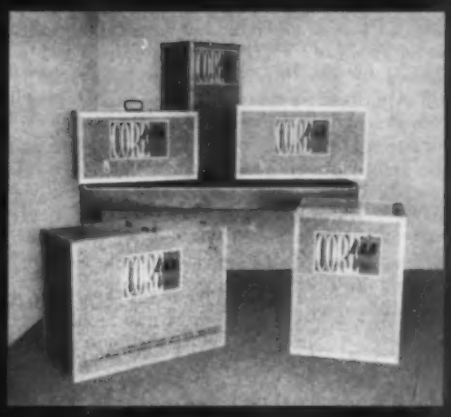

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Exploration

BOLIVIA

White Eagle Begins Aerial Exploration

Aerial exploratory work on petroleum concessions in Bolivia is now in progress by a three-company group of White Eagle International Oil Company, Western Hemisphere Petroleum Corporation, and Blackwell Oil & Gas Company, all of Tulsa, Oklahoma. Aeromagnetic Surveys Ltd. of Toronto has been retained by the three-company operation to perform photo-grammetric and aeromagnetic survey over the entire concession area.

White Eagle International, Western Hemisphere and Blackwell hold in excess of 2,200,000 acres under concession in the Eastern Plains Basin of Central Bolivia, adjoining concessions held by various major oil companies including Gulf, Standard of California, and Shell. The group's concessions were formally granted on December 31, 1957.

It is expected that the aerial photography will be completed by the middle of November.

IRAN

Ahwaz Gets Exploration Push

Exploration work by the Iranian Oil Exploration & Producing Company, which operates southern Iranian fields for the Consortium and for the National Iranian Oil Company, will be focused in the Ahwaz and Kuh-i-Binak area during 1958.

Exploration work in the current season is being carried out by eight field parties: Two geological, three topographical and three geophysical, who are working in the subcoastal strip approximately 50 miles deep stretching over 800 miles from Ahwaz to the southern end of the Agreement Area at Bandar Abbas.

Two rigs will carry out the company's exploration drilling program at Ahwaz and at Kuh-i-Binak near the Persian Gulf Coast, north of Kharg Island. One rig will carry out an exploitation program at Naft Safid and three each at Agha Jari and Gach Saran.

VENEZUELA

Pancoastal, Atlantic Put Discovery on Pump

Pancoastal Petroleum Company and the Venezuelan Atlantic Refining Company have placed on the pump a new oil discovery on the jointly-owned 6200 acre Pirital concession, in the Punta Gordo area in Eastern Venezuela. Initial test production of the new well, Pirital No. 6, was 240 bbl daily of 19 deg crude through perforations from 1210 to 1280 ft.

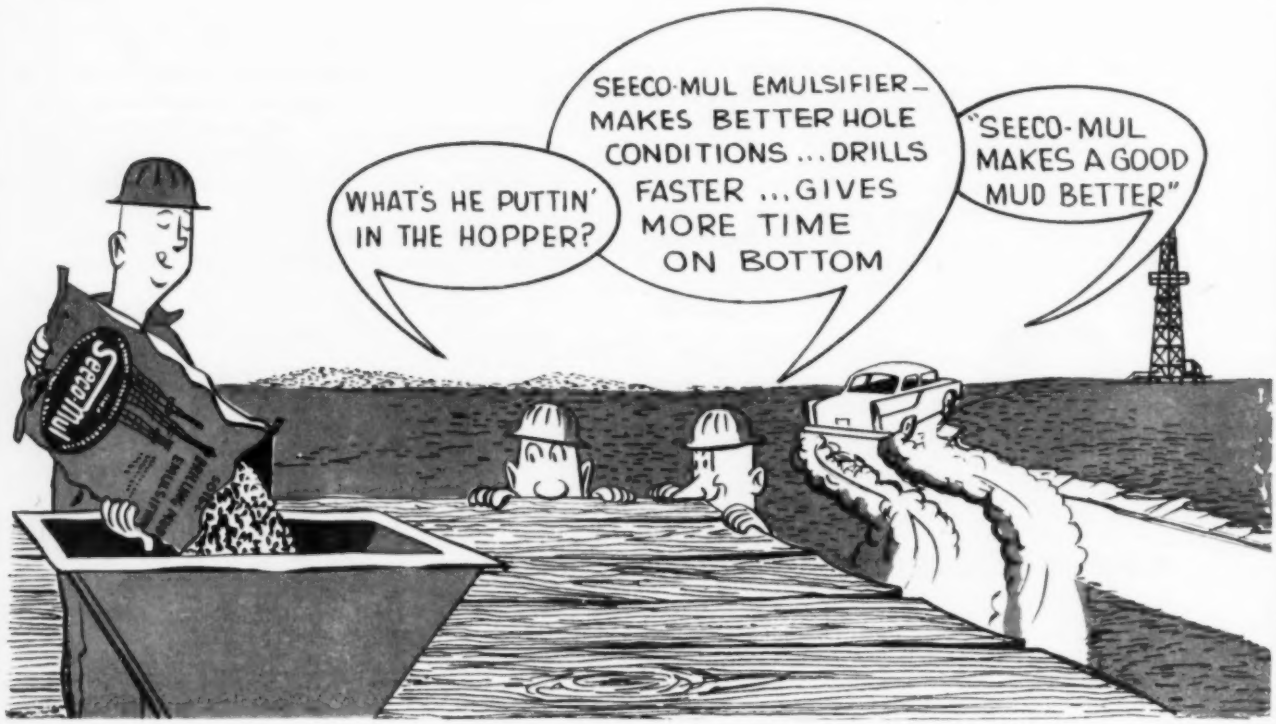
WEST GERMANY

Oil Discovery in Wuertemberg

Oil has been discovered in the exploratory well of the Wintershall-Gewerkschaft Elwerath consortium, Moenchsrot 2, which was drilled approximately 8 miles west of Memmingen. This well has in all probability opened up the first commercial oil deposit in the province of Wuertemberg. The discovery will encourage the oil companies to continue their search for oil in the deep Molasse Basin north of the Alps, which extends from Lower Austria far into Switzerland.

The pioneer well Moenchsrot 2 was specially drilled to search in a position higher on the structure for the sands of the Freestone beds, which had already been encountered in the well Moenchsrot 1 and had been found to contain good oil traces. The new well was perforated between 4852 and 4841 ft as well as between 4834 and 4811 ft; production tests were successful after the well was placed on the pump.

Nothing definite can as yet be said about the extent of the geological structure at Moenchsrot. The new oil deposit is located approximately 6 miles west-south-west of the producing Heimertingen oil field beyond the Iller River in Bavaria. Moenchsrot is so far the westernmost oil field in the basin.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OHIO

Erie Natural Gas to Drill Promising Ohio Acreage

Erie Natural Gas Company, Inc., began drilling three wells in March in extremely promising northeastern Ohio, in a region that has seen nine new gas wells and four oil strikes in recent months.

Erie's drilling activity will take place on 900 acres of the Monroe Township pool, in Ashtabula County.

The new Erie wells are in Sections 25, 33, and 35 at Monroe. A farm-out arrangement has been completed with Benedum-Trees, Hiawatha Oil & Gas Company, and Penn-Ohio Gas Company. The three firms, operating as a unit, will retain a small, overriding royalty.

The first well, Erie Murtha No. 1, is a half mile from Oroszy No. 1, a 45 bbl per day discovery by Benedum-Trees.

Total depth of each well will be 3500 ft or to the top of the Queenston shale formation, thus testing at least four potential pay zones.

BRITISH HONDURAS

Bandini Concessions Approved

Bandini Petroleum Company has formed Belize Petroleum Company, Ltd., wholly owned subsidiary, to hold prospecting licenses and to carry on exploratory work in Bandini's holdings in British Honduras.

Bandini is formalizing its concessions in British Honduras; the government there already has approved Bandini's concession requests.

Belize will have prospecting licenses on 958,000 acres, a working agreement with West Caribbean Oil Company on prospecting licenses on an additional 908,000 acres and, further, an agreement with Gulf Oil Company to acquire another 144,000 acres in leases. All of these properties are located in the southern half of British Honduras and the combined prospecting licenses and leases will total more than 2,000,000 acres. Boyer indicated that this acreage covers a majority of the potential oil prospects in that section.

Photo-geologic studies were recently completed and photo and field information indicate that there are from 8 to 10 prominent structures in the outcrop area of these holdings. Spokesmen indicated that upon completion of additional geologic work the company plans to drill a test well on a structure in the Punta Gorda area. The Bandini holdings are immediately adjacent to those of Signal Oil Company in bordering Guatemala where that company recently stated it has six definite structures.

BRITISH COLUMBIA

Gas Discovery at Clarke Lake

Gulf States Oil Company of Canada, a subsidiary of Western Natural Gas Company, has completed a gas discovery well from the Slave Point section of the Middle Devonian. The well, the Clarke Lake No. 1-A, was completed with a daily potential of 8,000,000 cu ft from a depth of 6438 ft.

The discovery is on a 252,672-acre permit obtained from Imperial Oil, Ltd. Gulf States and El Paso Natural Gas Company earned half interest in the permit by drilling the well.

FLORIDA

Humble Plugs Lone Prospector

Florida's lone exploratory well has been abandoned by Humble Oil & Refining Company at a depth of 12,800 ft. The well, No. 1 State, in Palm Beach County in the Everglade Swamps of southern Florida, found only dead black oil traces in a dolomite at 9740-10,000 ft.

Geological tops released by Humble were: Upper Cretaceous at 5293 ft; Lower Cretaceous at 8197 ft; Fredericksburg at 9542 ft; Trinity at 10,982 ft; Sunniland at 11,424 ft, and Lower Massive anhydrite, 11,624 ft.

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What's doing in DRILLING

U. S. Drilling Activity on the Upswing

Drilling activity, which has declined steadily in the U. S. and Canada since the first of the year, has at last leveled off, and some industry contractors are cautiously predicting that the hoped-for upward swing has begun.

Although the total count of active rigs in the U. S. and Canada for the week ending April 7, 1958, dropped to 1906 from 1923 the week before, drilling in the U. S. has continued to increase from the 11-year low of 1694 registered on March 17. Seasonal bad weather in Canada has caused most of the cutback in Canadian activity during the past few weeks.

Fred Carlson, economic analyst of Dresser Industries, Inc., stated that he doubts that drilling would fall below the low reached in March. He explained that most of the cutback in drilling has been made by the independent producers, who account for approximately 80 percent of wells drilled. The major companies have set their drilling programs and should at least hold at current activity levels.

High well costs, low allowables, and high stocks, along with unusually bad weather in some parts of the U. S., have received most of the blame for the drilling slump.

Falcon Seaboard Makes Safety Award

The "Rig of the Year" annual safety award of Falcon Seaboard Drilling Company has been announced by T. N. Law, Sr., president of the organization. The award went to Falcon's Rig No. 27, supervised by C. O. Pritchett, and drillers Halo Ramsey, D. J. Warden, and Jack Rush.

During 1957, the 96-ft jack-knife double rig operated 250 days on 14 locations in Kansas and Oklahoma without a single injury of any kind.

Superior Cuts Out California Drilling

Along with an announcement of cut-back production, Superior Oil Company has announced that it plans to cut out all drilling in California except for present lease contract requirements. Drilling has also been cut by the company in Utah.

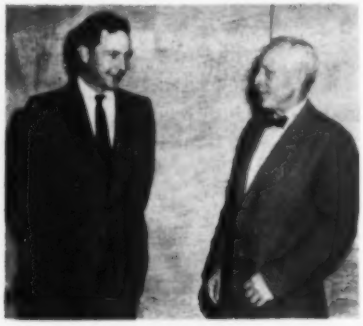
Howard B. Keck, Superior president, stated simply that his company considers onshore wildcatting in California profitable and that California legislation may well make offshore exploration unattractive.

Keck stated that his company is looking at Louisiana, Canada, Venezuela, and other South American areas as good prospects for future oil exploration and development, and that Superior is also interested in the Sahara, Lybia, Turkey, and Nigeria.

Drilling Platform to Work in Lake Erie

A submersible drilling platform for use in Lake Erie is now being built for the New York Natural Gas Company. The 50-ft-square barge will be equipped with a contract drilling rig and used to explore the gas company's large lake tract leased from the state of Pennsylvania.

The first well drilled by the unit will be spudded early this summer at a location about four miles offshore. The platform will be equipped with crew living quarters and two-way radio communication.



W. R. "Bill" Johnston, left, new general manager of Aspen Drilling Company, and J. C. Johnston, Bill's father, and regional manager of Continental Oil Company's production department at Denver. The elder Johnston will join the new Aspen Drilling Company when he retires from Conoco in August.

New Drilling Contractor in Four Corners Area

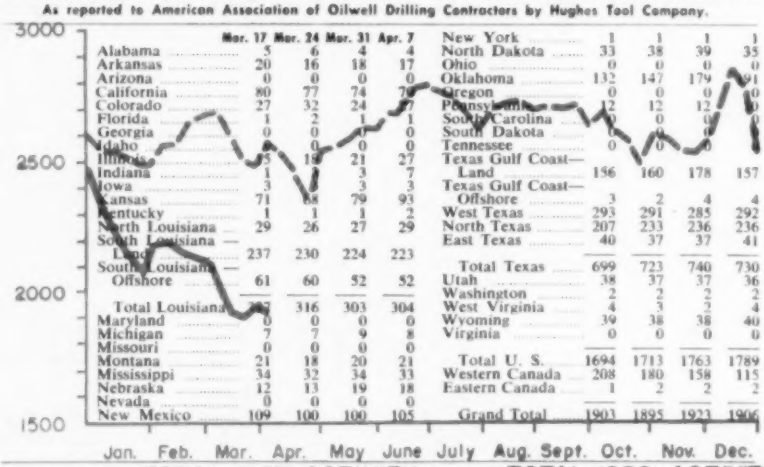
In the face of decreased drilling activity, a new contract drilling firm, Aspen Drilling Company, has begun operations in the Four Corners area. The firm is a father, son and daughter group headed by W. R. "Bill" Johnston. Johnston was formerly manager of production operations for Northwest Production Company, Albuquerque.

J. C. Johnston, Bill's father, is regional manager of Continental Oil Company's production department in Denver; he will join Aspen in August upon retirement from Conoco. J. C.'s daughter, Mary Johnston, Denver oil and gas attorney, is secretary of the new company.

Aspen is now operating with two rigs and will work primarily in the Four Corners area of Colorado, New Mexico, Utah, and Arizona. Company offices will be in both Albuquerque and Denver.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.



	Mar. 17	Mar. 24	Mar. 31	Apr. 7
Alabama	5	6	4	4
Arkansas	20	16	18	17
Arizona	0	0	0	0
California	80	77	74	76
Colorado	27	32	24	27
Florida	1	2	1	1
Georgia	0	0	0	0
Idaho	0	0	0	0
Illinois	25	18	21	27
Indiana	1	1	3	7
Iowa	3	3	3	3
Kansas	71	88	79	93
Kentucky	1	1	1	2
North Louisiana	29	26	27	29
South Louisiana — Land	237	230	224	223
South Louisiana — Offshore	61	60	52	52
Total Louisiana	327	316	303	304
Maryland	0	0	0	0
Michigan	7	7	9	8
Missouri	0	0	0	0
Montana	21	18	20	21
Mississippi	34	32	34	33
Nebraska	12	13	19	18
Nevada	0	0	0	0
New Mexico	109	100	100	105
New York	1	1	1	1
North Dakota	33	38	39	35
Ohio	0	0	0	0
Oklahoma	132	147	179	191
Oregon	0	0	0	0
Pennsylvania	12	12	12	10
South Carolina	0	0	0	0
South Dakota	0	0	0	0
Tennessee	0	0	0	0
Texas Gulf Coast—Land	156	160	178	157
Texas Gulf Coast—Offshore	3	2	4	4
West Texas	293	291	285	292
North Texas	207	233	236	236
East Texas	40	37	37	41
Total Texas	699	723	740	730
Utah	38	37	37	36
Washington	2	2	2	2
West Virginia	4	3	2	4
Wyoming	39	38	38	40
Virginia	0	0	0	0
Total U. S.	1694	1713	1763	1789
Western Canada	208	180	158	115
Eastern Canada	1	2	2	2
Grand Total	1903	1895	1923	1906

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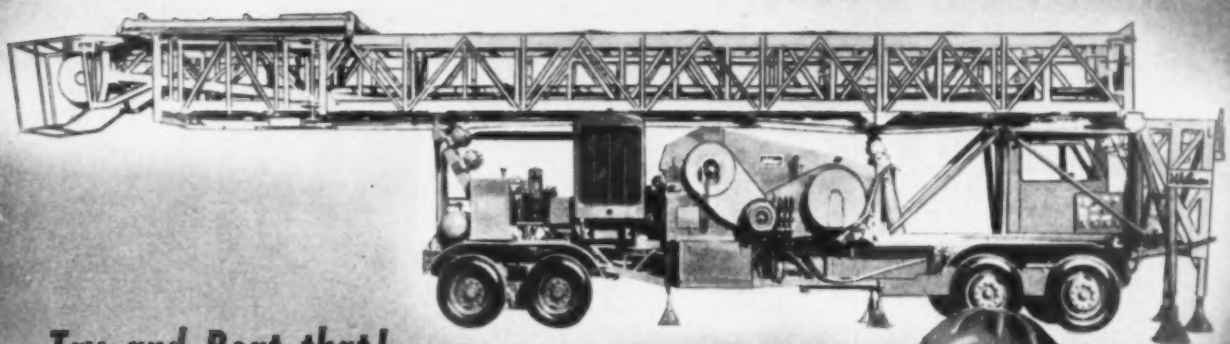

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Drilling

Garvey Drilling Refutes Russia's Record Claim

Soviet sources recently claimed that a Russian drilling crew set a world record by making 128,572 ft of hole in 1957 with a single rig. But Claude W. Bard, general manager for Garvey Drilling Company at Great Bend, Kansas, has the records to prove that the Russians were a bit hasty in their claim to the world record.

Three of the company's rigs working in the Denver-Julesburg Basin tallied up the following record last year: One rig drilled a total of 130,926 ft of hole, another rig cut a hole through a total of 149,673 ft, and still a third amassed a remarkable total footage drilled in 1957 of 166,159 ft.

McNisco, Inc. Receives Drilling Barge

The Levingston Shipbuilding Company has delivered a drilling barge, the submersible unit "Mister E. J.," to the McNisco, Inc. of Houston. It will be operated by the Nicklos Drilling Company and was named in honor of the founder of the company, the late E. J. Nicklos.

The vessel, measuring 180 ft long, 50 ft wide, and 12 ft deep, headed for its first location in Mallard Bay in Louisiana marshland country.

AAODC Chapter Honored for Drilling School Work

A bronze plaque honoring the Permian Basin Chapter of the American Association of Oilwell Drilling Contractors for its work in furthering drilling education was presented to the chapter at a recent meeting.

The plaque, presented to Chapter Chairman D. F. Garrett of Midland, was awarded in recognition of the chapter's "initiative, work and sustained effort in establishing and maintaining the School of Drilling Technology at Odessa College at such high standards."

The eighth consecutive term of the six-week school at Odessa began February 10. The course, for drilling industry supervisory personnel, is conducted by the University of Texas under AAODC sponsorship.

Depletion Allowance At Work

In 1957, Magnolia Petroleum Company set the deep-drilling record in Oklahoma by drilling the No. 1 Sterba to a depth of 20,466 ft. But the venture left Magnolia with a dry hole costing $1,054,500.

As a point of interest, Magnolia has announced that it would take the full depletion allowance from 658 of the company's average producers for one year to cover the cost of the duster.

New Mexico Claims Highest Success Ratio

Wildcat drilling operations in New Mexico in 1957 resulted in a success ratio of 25 percent in the state. The national average for the year was only 14 percent. Drilling in New Mexico resulted in the discovery of 40 new oil and gas pools.

Reading & Bates Christens Platform

One of the newest mobile drilling platforms to join the Gulf Coast fleet was recently christened in New Orleans. The platform, dubbed the "C. E. Thornton" for Reading & Bates Offshore Drilling Company, was purchased from R. G. LeTourneau, Inc.

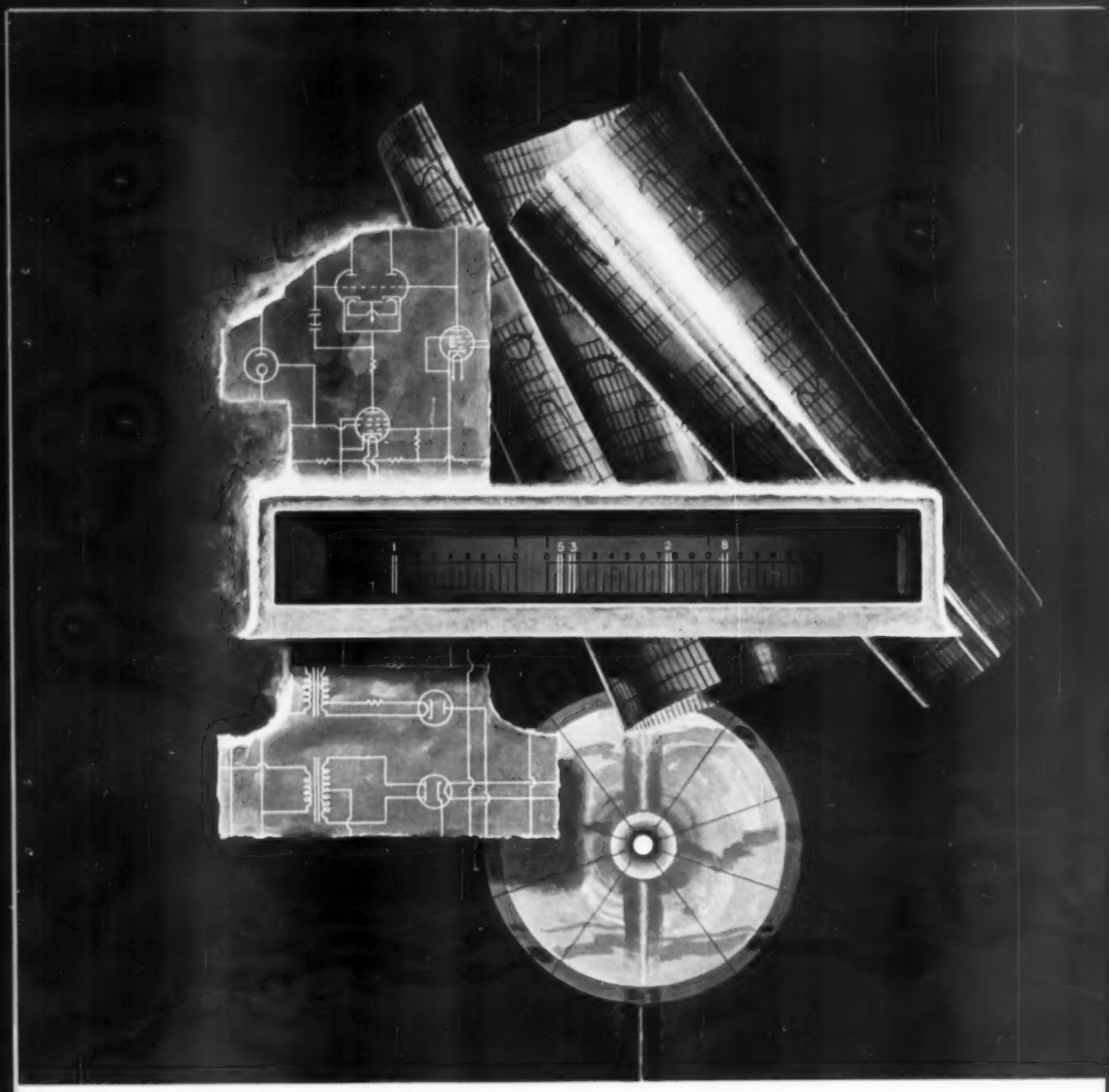
The 3000-ton platform cost less than $2,000,000, although drilling equipment and other facilities aboard raised the total investment to approximately $2,800,000.

Highlighting the commissioning ceremonies was an announcement that a contract had been signed which would put the unit to work for the CATC Group in Block 115 of the East Cameron area off the Louisiana Coast.

Power Swivel Eliminates Rotary Table

A new drilling tool developed by the Baash-Ross Division of Joy Manufacturing Company should speed up drilling rates, especially in offshore operations. The device is a rotary power swivel which can be driven hydraulically, electrically, or by air. Attached to the upper end of the drill pipe, the unit permits use of multi-joint stands of pipe, reducing the number of connections made while making a trip with the pipe. Stand length is limited only by the height of the derrick.

Units of up to 160 hp have been developed and tested in the field. Large swivels are being developed and units as large as 600 hp are being considered.



So you can look where you can't see

Oil industry technology took a big step forward when the Schlumberger Electrical Log was developed. Ever since the day oil was discovered, man has "strained his eyes" to see underground in an effort to accurately determine oil deposits.

The basic Schlumberger Electrical Log gave the industry eyes to see with . . . eyes that have been the first to see most of the present oil reserves throughout the world.

The Schlumberger Electrical Log . . . the pioneer system for all logging techniques . . . has been refined and improved year after year, along with resulting companion services. It is a quick, economical and accurate method of securing a permanent record of the formation penetrated. It is the master key to successful exploration.

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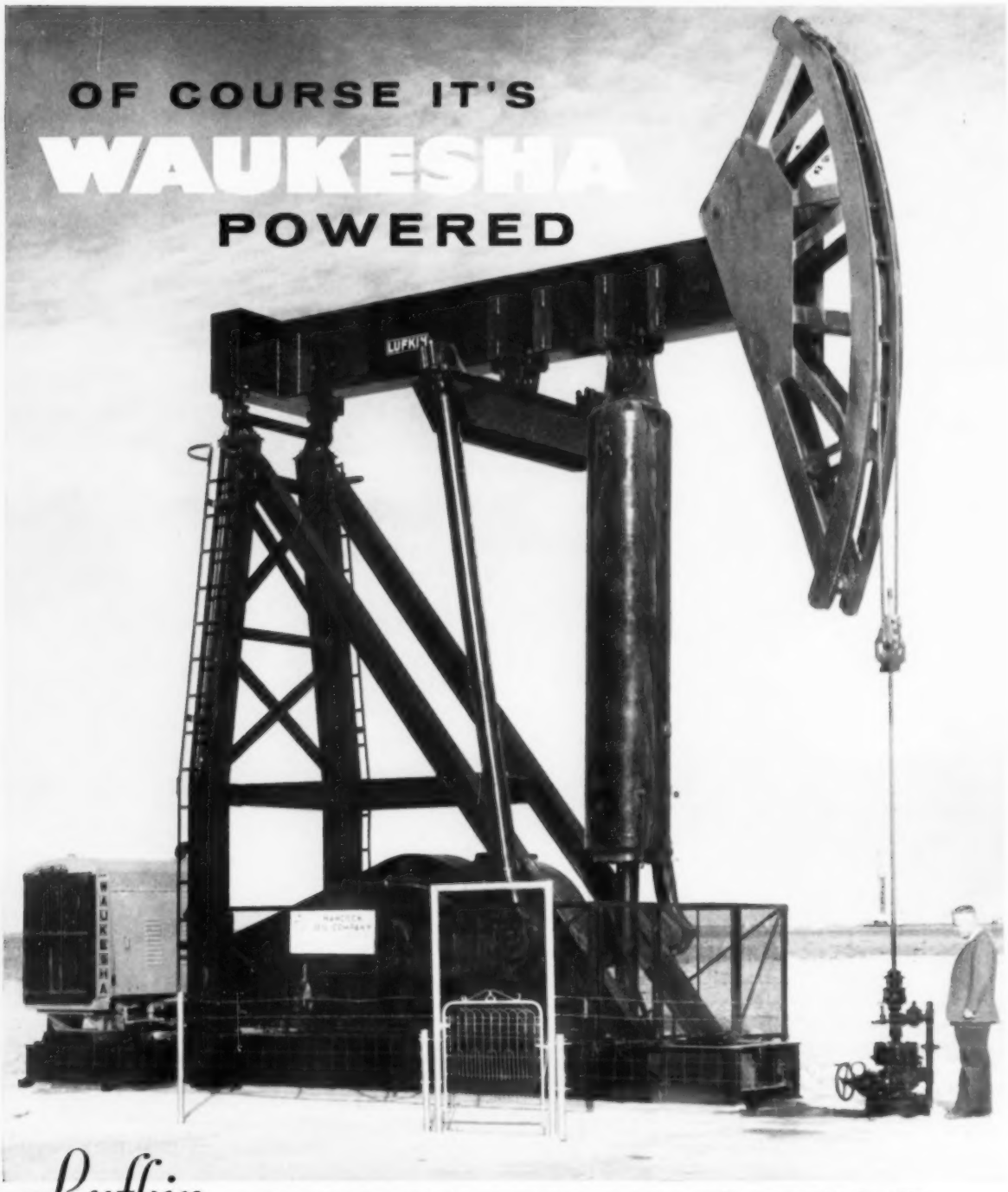

Lufkin . . . the largest beam type pumping unit built

Owned by the Hancock Oil Company and operating on their lease near Tatum, New Mexico — this A-1500D-192-42 air balanced Lufkin pumping unit has a 16-ft. stroke and a gear box with a capacity of 1,500,000 inch pounds. It is the largest beam type pumping unit built. It has a Waukesha Long-Life WAKU Oil Field Gas Power Unit, with an 1197 cu. in. six-cylinder engine, 6¼-in. bore x 6½-in. stroke. This is the second of these large units bought by Hancock Oil Company. That says a lot for the satisfaction-in-use of this reliable Lufkin-Waukesha combination.

Send for Waukesha Bulletins 1702 and 1079.

379

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ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Secretary Seaton Urges Caution . . .

RISE IN 'UNETHICAL' LEASE SPECULATION

Investors should be cautious over advertisements soliciting investments in oil and gas leases on lands owned by the Federal Government, says Secretary of the Interior Fred A. Seaton.

In a recent letter to the Better Business Bureau, Chicago, Illinois, Secretary Seaton outlined his Department's stand on the situation. The Better Business Bureau had written him that it received numerous inquiries from the public on oil lease promotions.

"During the past several years, numerous advertisers in newspapers and other periodicals throughout the nation have been offering for sale to the public Federal oil and gas leases," Secretary Seaton replied.

"Generally, they offer 40-acre oil and gas leases for $100. The public may be lured into purchasing these through the use of such psychological boosters as maps showing oil activities in a particular state. Many prospective purchasers cannot distinguish between development and 'wildcat' drilling. Contrary to what some of these advertisements imply, only a few, at the most, can be lucky enough to 'strike it rich' blindly.

"The leasing of lands desirable for oil drilling involves the use of technical skill and science and requires the investment of considerable risk capital. Literature reporting oil strikes may be misleading to the average layman who does not know how much time and effort go into the selection of drilling sites and the determination of oil and gas problems. Many of the purchasers of such leases lose their investments therein since oil exploration is highly speculative."

Secretary Seaton pointed out that "no organization or individual is authorized by the United States to solicit the public for the purpose of inducing persons to purchase oil and gas leases on the public lands, and no one advertising such a service or offering such a service through the mails is connected in any way with the government."

He also said that any citizen of the United States may apply for a Federal oil and gas lease, without the intervention of any agent. This is in accordance with the Mineral Leasing Act of February 25, 1920, as amended.

Departmental regulations were amended in 1952 to discourage the commercial offering of 40-acre leases. The amended regulations provided that a lease for less than 640 acres would not be issued except under certain circumstances.

Secretary Seaton explained "this does not, however, prevent any qualified individual, partnership, corporation or unincorporated association from obtaining a lease from the government up to 2560 acres and thereafter assigning portions thereof to qualified assignees. We cannot, under the law, refuse to approve an assignment of lease where all the regulatory requirements are complied with and the assignee is qualified to hold a lease. Thus, although the regulations do not permit the issuance of an oil and gas lease for less than 640 acres, the advertisers are still able to offer to the public 40-acre tracts assigned out of larger leases.

"This problem has received a great deal of study, but no final solution to it has yet been reached," he wrote.

IT'S THE NEW JENSEN ROTARY BALANCED JACK

You've heard about it! Here it is! The all-new ROTARY SERIES of full crank balanced pumping jacks now offered by JENSEN in addition to their famous Standard Series. The rack-and-pinion system on this JENSEN RB JACK makes weight adjustments a safe and simple operation for one man standing on the ground. Weights are shifted in such a manner to give lead and lag counterweight effect, where such operation is desirable.

All cranks and weights are floor clearing, permitting installation on flat concrete surfaces or simple steel skids. Thus eliminating expensive special foundations and crank weight wells.

This new Rotary Series of JENSEN JACKS has larger and heavier main shafts and bearings, and taller sampson posts.

Let us send you a free catalog that will give you all the specifications on this new Rotary Series. A call or a letter will bring it to you *quick!*

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JENSEN JACKS

IMPORTANT NEW FIELD TEST OF INJECTION WATER QUALITY

In this unique program, 20 college students of the Southwest will also demonstrate the iron sequestering ability of citric acid...give dramatic proof to secondary recovery operators!

● If you are responsible for water flooding operations in Texas, New Mexico, Louisiana, Oklahoma, Arkansas or Mississippi, a man from *Program 20* is coming your way. He is a chemistry or chemical engineering major from one of the leading colleges. He's working for Pfizer this summer—and getting valuable experience!

Pfizer hired him to test the quality of your injection water, to determine the iron content, and to demonstrate the outstanding utility of citric acid in preventing "iron plugging".

He will also give you information on the use of citric and gluconic acids with detergents in well clean out procedures, and information on the use of these same acids in HCl acidizing.

He will leave with you a complete test report and a Fact File that includes comprehensive technical information and research data for secondary oil recovery. **The test and data are FREE.**

This is an unusual opportunity for you!

Welcome the man from Pfizer Program 20!

CHAS. PFIZER & CO., INC. PE
Program 20 Headquarters
7600 Ambassador Row, Dallas 35, Texas
Please have a *Program 20* man contact me:

Name_____
Title_____
Company_____
Address_____
_____ ☐
Telephone_____
Flood Site Location_____
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Check the location where you would like to be contacted.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Here's what the AAODC president sees ahead for drilling

A LETTER TO THE CLASS OF '58

A condensation of remarks presented before a number of leading universities

J. U. Teague, American Association of Oilwell Drilling Contractors, Columbia Drilling Company, Houston, Texas.

ENGINEERING knowledge is a flexible tool. It is principally through the application of this tool that the petroleum industry has advanced to its present position as the world's primary source of energy. We are definitely living in an oil age and nothing appears for the moment on the horizon to replace it as a principal source of power.

Even so, you are possibly perplexed as many of the rest of us are, by the bad news about the oil industry that has been so prominently in the headlines in recent months. It is true that the industry is in a slump now. But there are a few points worth remembering when you read these hard times stories in the papers.

1. *The "prosperity curve" of most industries is cyclic in nature. This is especially true of petroleum, and specifically true of the drilling segment of the industry.*
2. *The oil business is sensitive to events occurring outside the industry. It responds to external economic influences, good or bad. The domestic oil industry is also subject to the vagaries of foreign petroleum operations.*

To amplify the first point, this is not the first time the oil industry has had troubles. Periods of overproduction, one of the main problems of the industry today, occurred as long ago as the 70's, 80's, and 90's. The drilling industry in particular has had its ups and downs ever since it began. A study made in 1952 by two economists demonstrated that the curve of drilling activity swings high or low every four to seven years. We are today at a low point, and trust that the cyclic upswing will occur within relatively few months.

Oil's Economic Problems Today

Currently, more significant are the events of the past year or two that have created problems for oil.

1. **Excessive oil imports** have had a big part in the decline of the domestic drilling industry, by diverting funds that might have been used to finance drilling in the U. S.
2. **Oil demand did not increase** as much last year as we thought it would, or should.
3. **Burdensome stocks of crude** oil, resulting largely from overproduction last year during the Suez crisis, have discouraged producers from exploring and drilling for new oil reserves.
4. **Markets have shifted.** For example, Texas, while still the leading oil producing state, is now sharing crude oil markets with other states where production has been increased.
5. **Petroleum products are competing** with each other for the same market. More and more Eastern communities are using natural gas, instead of fuel oil, for heat.

Now, faced with these deterrents, what is the future for the petroleum industry, and for the young man casting his lot with it?

A Look at What's Ahead

The starting point for forecasting the future of an industry is to determine its essentiality. Today, petroleum is a vital factor in virtually every industry. Far beyond its primary use as a power source, petroleum is also raw material for plastics, cosmetics, drugs, fabrics and an infinite variety of other products. As new products are developed, so will the need for more petroleum.

Added to this factor pointing to increased consumption is the observable phenomenon of population growth. The return of the old-fashioned large family is an important factor in predicting future petroleum demand.

Consumption grows. We are now consuming in the U. S. about 9,000,000 bbl per day of petroleum products. Only a few years ago it was 6,000,000 bbl a day. Statisticians have told us, at least until very recently, that the United States will soon be using as much as 14,000,000 bbl daily. We know that the consumption last year was not up to expectations and that the present outlook is a bit discouraging, but over a 12-year period we are still hopeful that the upward trend will continue in a fairly even manner.

Future is bright. With the recognized requirement that we must keep producing most of our own petroleum, it makes your future as an engineer in the oil industry look at least as stable as if you had gone into some other basic industry.

I believe that we must continue exploring for oil on an adequate and even

Tips on Valves for Service Companies..

Ken Massey, Cardinal station manager, supervising sand frac job in West Texas. Note Rockwell-built Mudwonder valves on frac-head in background.

We maintain sand frac fluid pressure with Mudwonder Valves!

by Kenneth Massey,
Odessa Station Manager
Cardinal Chemical Company

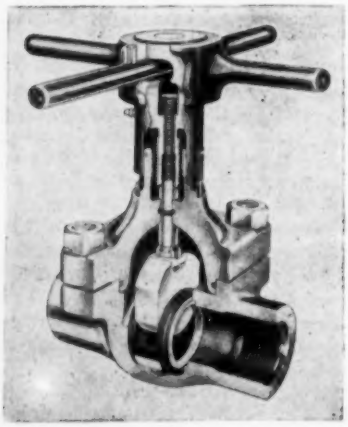
WE fracture oil wells. It's our job to get the maximum number of barrels pumped in the shortest possible time. That's why we use the best, most dependable equipment available—and drive it hard. When we finish pumping the sand frac fluid in under high pressure and close the well-head valves, we've got to be *sure* they don't leak. For two years now, we haven't had to worry. We find that well pressure never bleeds off when our Mudwonder valves are closed. There's no need to bump them shut or use a "cheater" to get drop-tight shut-off.

We now have 40 two-inch Mudwonders and several three-inchers. You might think maintenance would be a headache—but our Mudwonders don't seem to need much in the way of repairs. The only part that wears to any extent is the seat insert, which we can replace in a couple of minutes between jobs.

At the present time, we're using Mudwonders at all of our stations—Odessa and Levelland, Texas, and at Hobbs, New Mexico. We're thoroughly sold. Mudwonder valves are doing a great job for us, both on sand fracing and in acidizing.

Mudwonder valves are built in 2", 3" and 4" sizes; with screw or flange ends; for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test) service. See your favorite oil field supply store, or write Edward Valves, Inc., East Chicago, Indiana, subsidiary of Rockwell Manufacturing Company.

Mudwonder cut-away view shows the one-piece seat insert, with Buna-N molded integrally over steel wear rings; chromed gate with "T" slot connection; separated stainless stem and double thread construction.



expanded basis to maintain our position in the world market and guard against any national emergency requiring tremendous amounts of oil.

To speak specifically of the drilling business, there are some interesting calculations that will point out the need for additional drilling volume.

Drilling and reserves. Last year, domestic reserves of petroleum declined some 349,000,000 net bbl from the 1956 level, according to the American Petroleum Institute. There was also a decline in drilling, from 58,271 wells in 1956 to 53,668 in 1957. Reliable industry figures show that approximately 70,000 bbl of petroleum reserves were developed for each well drilled during the past 30 years. On this basis, it is reasonable to believe that if the 1956 drilling activity levels had been maintained, the 4603 additional wells that would have been drilled in 1957 would have added 322,000,000 bbl of domestic petroleum reserves.

Granted that this is hypothetical, it nevertheless supports a strong argument for the need for increased drilling activity. Currently, only a little more than half of the 3600 rotary drilling rigs in the U. S. are running. I have faith enough to believe that this percentage will increase as producers regain confidence to accelerate drilling programs.

Men in this business. The drilling business as any other is better measured by its men than by its machinery.

There are between 50,000 and 60,000 people working in the drilling industry. Engineers and other technically-trained men have achieved a high point in recognition, as opposed to a limited recognition from a field standpoint 30 years ago.

Today, the technical man is welcome on any rig and in any oil field, and the practical man has learned to work ef-

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ficiently with him. This is of extreme importance to you, since you will be required to work with all types of men and possibly under the direction of a practical man who has an outstanding basic knowledge of his particular function.

Engineers in the drilling business, including those who work for manufacturing and supply companies, are responsible for the tremendous improvement in drilling efficiency that has taken place in recent years. Average drilling time is only 54 percent of what it was in 1941. Generally, the credit goes to better methods and equipment, developed by engineers.

The challenge ahead. There are a great many challenges remaining to the technical man in the drilling industry. The future of the business depends largely on being able to drill a well faster and cheaper tomorrow than we can today.

Some of the most important work being done toward this goal is through the American Association of Oilwell Drilling Contractors, which has a very active drilling technology program. About 90 first-rate drilling engineers take part in the various phases. They are running field tests on slim hole and air/gas drilling, the effect of various weights on the bit and rotary speeds on penetration, and crooked hole problems, among other aspects. We expect to get some answers out of this work that will help us speed up drilling even more.

A further challenge to the young engineer entering drilling is that wells are being drilled deeper, and in stranger places. It may be more than coincidence that the deepest producing well in the world is offshore, a situation that presents a pair of challenges that could not have been met ten years ago.

Drilling here to stay. There can be no question that the drilling business is here to stay, and that engineers are going to be of greater and greater importance.

At the same time, a career in drilling is not necessarily the answer to an eager undergraduate's prayer.

Certainly, I think it is a good business in an essential industry, or 1000 other drilling contractors and I would not be in it. At the same time, I know that a drilling career is not for everyone.

In the first place, it may not be absolutely necessary that an engineer start out in the drilling business as a crewman, but generally it is a very good way to learn how to drill a well.

There is also a tendency to prefer working for the bigger companies. Most contract drilling firms are not large, by other industrial standards. The challenge of independent enterprise is not to everybody's taste, and there is no reason why it should be.

Right job for right man. But there is a type of engineer who will be attracted to the drilling segment of the oil industry. He will be inquisitive, ready to learn something new (and your professors will be the first to tell you that an engineering education just begins when you get your degree), unafraid of work, and quite possibly intrigued with the idea of going into business for himself some day.

I assure you there is a job in the drilling industry for that fellow.

A university education lays a sturdy foundation for a future career. Like the foundation of a building, it is difficult to predict the design of the superstructure by looking at the underpinnings.

The prospectus for your future, then, are enhanced by your education, but not determined by it. Your career will be affected largely by your attitude toward your work. Only application of knowledge in a sensible manner will give you the combination that brings promotion and stability. ★ ★ ★

SEG NOMINATES OFFICERS

Six of the world's leading earth scientists have accepted nomination for office in the Society of Exploration Geophysicists, it was announced by O. C. Clifford, Jr., chief geophysicist of the Atlantic Refining Company, Dallas, Texas, and president of the SEG.

For president, E. V. McCollum, senior partner of E. V. McCollum & Company, Tulsa, Oklahoma, will oppose Bart W. Sorge, vice president of United Geophysical Corporation, Pasadena, California.

For vice president, Fred J. Agnich, president of Geophysical Service Inc., Dallas, will run against William M. Erdahl, chief geophysicist of Skelly Oil Company, Tulsa. Robert Dyke, chief geophysicist of the Tidewater Oil Company, San Francisco, and Kenneth R. Wells, vice president of General Geophysical Company, New Orleans, are the candidates for secretary-treasurer of the society. Dr. L. Y. Faust, geophysical supervisor for Amerada Petroleum Corporation, Tulsa, will continue for the second year in office as editor.

For president . . .

. . . McCollum or Sorge

The 3000 active members of SEG throughout the world will elect new officers from this slate in a mail ballot election to be conducted during June and July. A public announcement of the results will be made next August. Successful candidates will take office during the 28th annual international meeting of the society October 13-16 in San Antonio, Texas.

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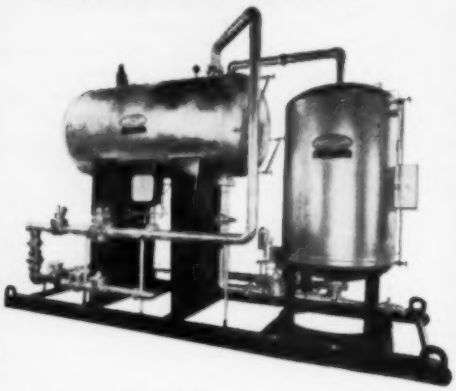

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Trouble-free operation, accuracy, and simplicity of design make the WELL TESTER practical and versatile for use in continuous production metering, gas-oil ratio tests, periodic production tests, marginal well tests, potential and reservoir studies, tax and royalty payments, comingling production, automatic lease operation.

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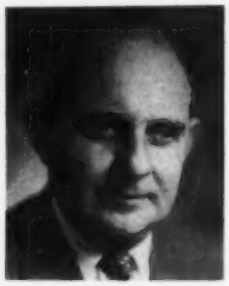
THE OASIS—
A gathering spot for NOMADS

Herb E. Maland



Maurice F. Delano, Jr.

Nomads Elect Maland, Delano

The Nomads National Board of Regents has elected Herb E. Maland as chairman, and Maurice F. Delano, Jr., as secretary-treasurer of the organization for 1958.

A native Californian, Maland worked on the Pacific Coast for several oilfield equipment companies in design, development and sales for nine years. After another year in the Gulf Coast, he went to New York where he has spent the last 20 years in export sales work. At the present time he is vice president of R. J. Eiche & Associates, Inc., and in charge of its New York export office, handling the sales of several well-known manufacturers of oil field and refinery specialty equipment.

Maland is a charter member of the New York chapter of Nomads, serving as its president in 1956 and Junior Regent in 1957. He is also first vice president of the "Pacific Coast Displaced Persons Club" of which he has been an active member. Maland was informed of his election while in Caracas where he is currently visiting oil company operations in Venezuela, Colombia, Aruba, Curacao, and Cuba.

Delano has traveled extensively in Central and South America and Europe on behalf of his firm and represented manufacturers. He is director and vice president of R. S. Stokvis & Sons, Inc., whom he joined in 1936 after attending Northeastern University.

A member of the New York Chapter of Nomads since 1940, he has held various offices over the years and was president of the New York Chapter in 1957.

Foreign Guests at the March 12, 1958 meeting of the Los Angeles Chapter of Nomads. (Left to right, standing) Alfred Kaufman of OMV from Austria; Wilhelm Mende of Deutsche Erdoel A-G, from Germany; A. R. Little of D&E from Nigeria; E. E. Jones of Shell Oil Company from Venezuela; Carl B. Jauman of Santa Fe Drilling Company from Kuwait; Harold Karnes of Santa Fe Drilling Company from Ghana; Jack Walsh of Santa Fe Drilling Company from Kuwait; Charles Henrite of International Brown Drilling Company from Turkey; James Francomacaro of D,M,J & M going to Thailand; A. B. Armer of D&E from Brazil; A. H. Bleyberg, consultant from Near East; Eric Hulme of Baker Trans-World from Maracaibo. (Seated) Paul Hughes of D&E from Brazil; B. A. Horan of Basra Petroleum Company from Iraq; Ziya Kirman of Istanbul Gas Company from Turkey and Albert Jensen of D&E from Brazil.

TORQUE IS IMPORTANT

Here's What The Experts Say About Tong Torque

– IMPROPER MAKE-UP IS THE CHIEF CAUSE OF TOOL JOINT FAILURE

– THE BEST METHOD OF ASSURING PROPER MAKE-UP IS WITH A TORQUE GAUGE

MARTIN-DECKER TONG TORQUE GAUGE

Claude L. Griffin
Vice-President, American Iron & Machine Works, Inc.

It is my opinion the major cause of tool joint failure is due to improper make-up torques. The best measure of assuring proper make-up torque is to use a tong torque indicator.

Wiley B. Noble
Vice-President Engineering, Reed Roller Bit Co.

The major cause of tool joint failure is improper torque. To my mind there is only one way to assure proper make-up and that is to use some sort of torque measuring device. The method employing a Martin-Decker Tong Torque Gauge seems to be the only straight-forward engineering approach to the problem.

- CAN BE USED FOR ANY SIZE TOOL JOINT, CASING OR TUBING
- IS ACCURATE, NOT JUST A ROUGH ESTIMATE
- IS RUGGED AND DEPENDABLE
- CAN BE PERMANENTLY INSTALLED SO THE SIGNAL IS ALWAYS AVAILABLE
- CAN BE USED AS A PORTABLE INSTRUMENT FOR SPOT CHECKS
- ENGLISH OR METRIC DIALS AVAILABLE

Stanley C. Moore
President, Drilco Oil Tools, Inc.

In my opinion, the great majority of all failures of rotary shouldered connection are the result of incorrect make-up torque.

We have made a great number of actual checks on the accuracy of estimated torque. We found values ranged from 25% to 160% of the recommended torque. The only way to assure make-up torque is by actual measurement.

Walter B. Reinhold
Sales Manager, Abegg & Reinhold

There can be little doubt that improper make-up is probably the most important single factor resulting in tool joint damage. Undoubtedly the best method of assuring proper make-up torque would be with a tong torque indicator.

TWO METHODS OF INSTALLATION AVAILABLE

The permanent installation of the Martin-Decker tong torque assembly is preferred by the drilling crew that desires tool joint make-up torque *each* time the drill collars are run with no special or extra installations necessary. This also allows the driller to check the make-up torque of the drill pipe as long as backup tongs are in use. Under certain conditions even the measurement of the breakout torque is available. During all measurements the gauge is conveniently mounted in front of the driller, easily visible at all times.

To make the permanent panel mount installation the gauge is placed in the Martin-Decker Weight Indicator box and 25 ft. of hose is extended to the hydraulic cylinder which is secured to the backup post or derrick leg. The backup line is permanently secured to the cylinder and will indicate a torque reading each time the backup line is in use.

The portable installation of the Martin-Decker rotary tong torque assembly is applicable when the instrument is used for intermittent use or for spot checks. In this installation the same instrument can be used for regular checks of the automatic cathead on two or more rigs in an area. It also provides a quick and easy check when running special collars or drill pipe.

The portable assembly consists of an indicating gauge with a bracket for tong handle mounting. A short cord connects the gauge to the hydraulic cylinder installed on the tong where the make-up line is attached. This instrument can be put into operation in a few minutes and will give a positive and accurate indication of the torque on any size tool joint. The most popular use of this assembly is on power tongs. In this case the Martin-Decker instrument is permanently mounted on the tongs and models are available for direct foot-pounds readings.

The experts all agree that make-up torque is important. Either the portable or permanent installation of the Martin-Decker tong torque assembly will provide the necessary information for more efficient rig operation.

WRITE FOR DESCRIPTIVE LITERATURE

MARTIN-DECKER CORP.

HOME OF THE WEIGHT INDICATOR — LONG BEACH, CALIFORNIA

RUNNING TOUR with MEN in the INDUSTRY

▸ **L. W. Folsom,** senior geologist for Mountain Fuel Supply Company, has been named manager of the company's exploration division, and **W. W. Skeeters,** also senior geologist, has been named chief geologist for the company.

Active direction of Mountain Fuel's exploration division formerly was supervised by **M. M. Fidlar,** vice president, who was transferred last week to company headquarters at Salt Lake City as senior vice president and assigned additional management duties.

▸ **John W. Clark,** of Dallas has been elected a director and vice president of Magnolia Petroleum Company. Clark was serving as assistant manager of the exploration division.

Ross F. Madole of Dallas has been elected to the board of Magnolia Pipe Line Company. He succeeds to the board vacancy created by the retirement of **David Levy.**

J. W. Clark

Joseph Zemanek Jr.

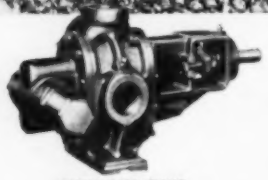
How They Rely on These ROPERS!

SERIES H PUMP
To 600 PSI—10 to 75 GPM
Packed box or mechanical seal. Widely used for gathering lines.

SERIES H AND SERIES 3600 PUMPS SPECIFIED FOR PIPE LINE HOOK-UPS

Regardless of the power supply used, ROPER PUMPS offer dependable service on continuous or intermittent pumping. These pumps give the advantage of design simplicity . . . two equal size, precision-mated gears run in axial hydraulic balance for positive displacement and assurance of smooth, non-pulsating flow in either direction of rotation. One of the outstanding features of the ROPER design is easy accessibility to the working parts. Neither piping nor mountings are disturbed whether for making a simple inspection or a major repair.

Specify ROPERS for close-in or remote installations. They will provide the *dependable pumping* you must have.



SERIES 3600 PUMP
To 100 PSI—20 to 300 GPM
Packed box or mechanical seal. For gathering lines or circulating and transfer.

ROPER HYDRAULICS, INC.
725 BLACKHAWK PARK AVE
ROCKFORD, ILLINOIS

ROPER
ROTARY PUMPS

▸ **Joseph Zemanek Jr.,** has been selected for a Socony Mobil Incentive Fellowship under which his studies toward a doctorate degree will be sponsored by the Magnolia Petroleum companies. The awardee is a senior research electrical engineer employed by Magnolia at its field research laboratory near Dallas, Texas. Zemanek plans to attend the University of California at Los Angeles for doctorate studies in physics, specializing in acoustics. His fellowship award allows him up to three years to obtain the PhD degree; he will receive full pay while he holds the fellowship.

▸ **Frank P. Sonnenberg** has been named chief geologist and **Paul D. Balbin** as chief geophysicist for Chaco Petroleum, S. A., Bolivian subsidiary of Tennessee Gas Transmission Company. Sonnenberg was a geological consultant with offices in Billings, Montana, immediately before he joined Chaco Petroleum. He was formerly employed with the Amerada Petroleum and Gulf Oil corporations. Balbin was for 20 years a geophysicist for the Stanolind Oil and Gas Corporation. Both will have headquarters in Cochabamba, Bolivia.

▸ **P. A. Robertson,** division economics geologist of Gulf Oil Corporation, Houston production division, has been transferred to Bahamas Gulf Oil Company in Nassau with the title of special representative. Robertson will have charge of all of Gulf's exploration and production activities in the Bahamas. He has been with the Houston division as geologist.

R. C. Frederick has been appointed coordinator for gas and gas liquids by Gulf Oil. He was formerly in the planning and economics department.

P. A. Robertson

J. S. Collins

▸ **J. Spencer Collins** has been promoted to exploration manager of the producing division of Tennessee Gas Transmission Company. Collins is in charge of domestic and Canadian operations. **J. M. Browning** recently was named exploration manager of the firm's overseas operations.

The promotions of **George E. Burgher Jr.,** and **L. B. Vaden** to managerial assignments in the oil and gas exploration department of Tennessee Gas Transmission were also announced. Burgher has been promoted to manager of exploration properties. He was formerly an independent oil and gas lease broker after periods of employment with the Stanolind Oil & Gas Company and the Baroid Sales Division of the National Lead Company. Vaden has been named manager of exploration acquisitions. He joined Tennessee Gas in February 1954, after being employed by The Texas Company and the American Republics Corporation.

▸ Under a reorganization plan recently announced, Shell Development Company's exploration and production research division and Shell Oil Company's technical service division, both in Houston, will consolidate into a single operating unit within Shell Development. The

(Continued on B-147)

American Iron KELLY DRIVE-BUSHING

eliminates damaging Kelly whip and gyration*

SELF-ALIGNING . . . the pivoted-cage rollers in the new American Iron Kelly Drive-Bushing actually compensate for the small crooks and bends in the kelly! Now—for the first time—here is a kelly drive-bushing that assures centered kelly rotation above to the swivel . . . and below to the drill string! Unlike other multiple-roller kelly drive-bushings, the new American Iron kelly drive-bushing does not cause damaging whip and gyration movement to be transmitted to the crown block and below to the drill string!

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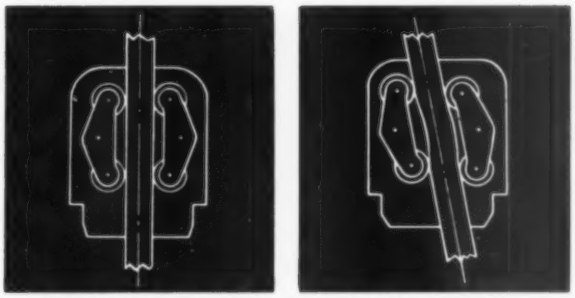
There are no adjustments to make, no shims to put in or take out when installation is made on the kelly with the new American Iron Kelly Drive-Bushing. It helps the crew hold down-time to a minimum when changing kellys.



Exclusive Pivoted-Cage Roller Design greatly increases life of all rotating parts!

Get all the facts now from your American Iron Representative or your Supply Store man.

Self-Aligning Rollers

Four caged roller units (8 individual rollers) pivot at cage base pins to allow for nominal amount of kelly misalignment without introducing bending motion in kelly.

Positive Lubrication

All rollers are lubricated directly. No indirect lubrication system to become clogged and endanger both bushings and pins. No special grease is required.

**Resulting from misalignment of rotary table or crooked kelly.*

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wherever you drill deep.....

. . . . . run REED field replaceable tool joints - tried and proven on high tensile drill pipe

REED Super Shrink-Grip

P-95 . . . X-95 . . . P-110 . . . S-135 . . . up go the numbers as deeper drilling requires higher and higher tensile drill pipe to provide the needed strength and toughness. Up go the working requirements for tool joints, too . . . but there's one tool joint already field-tried and field-proven for the highest tensile pipe and the deepest, toughest drilling—Reed Super Shrink-Grip tool joints.

For example, on one recent string of X-95 pipe for drilling in the 20,000 ft. range Reed Super Shrink-Grip tool joints were chosen because *standard production Super Shrink-Grip tool joints had tensile strength and thread shear strength in excess of the pipe maximums.*

Write or wire for complete information . . . or have your Reed representative call in person to explain the economic and engineering advantages of readily replaceable Reed Super Shrink-Grip tool joints.

REED ROLLER BIT COMPANY • Houston 1, Texas

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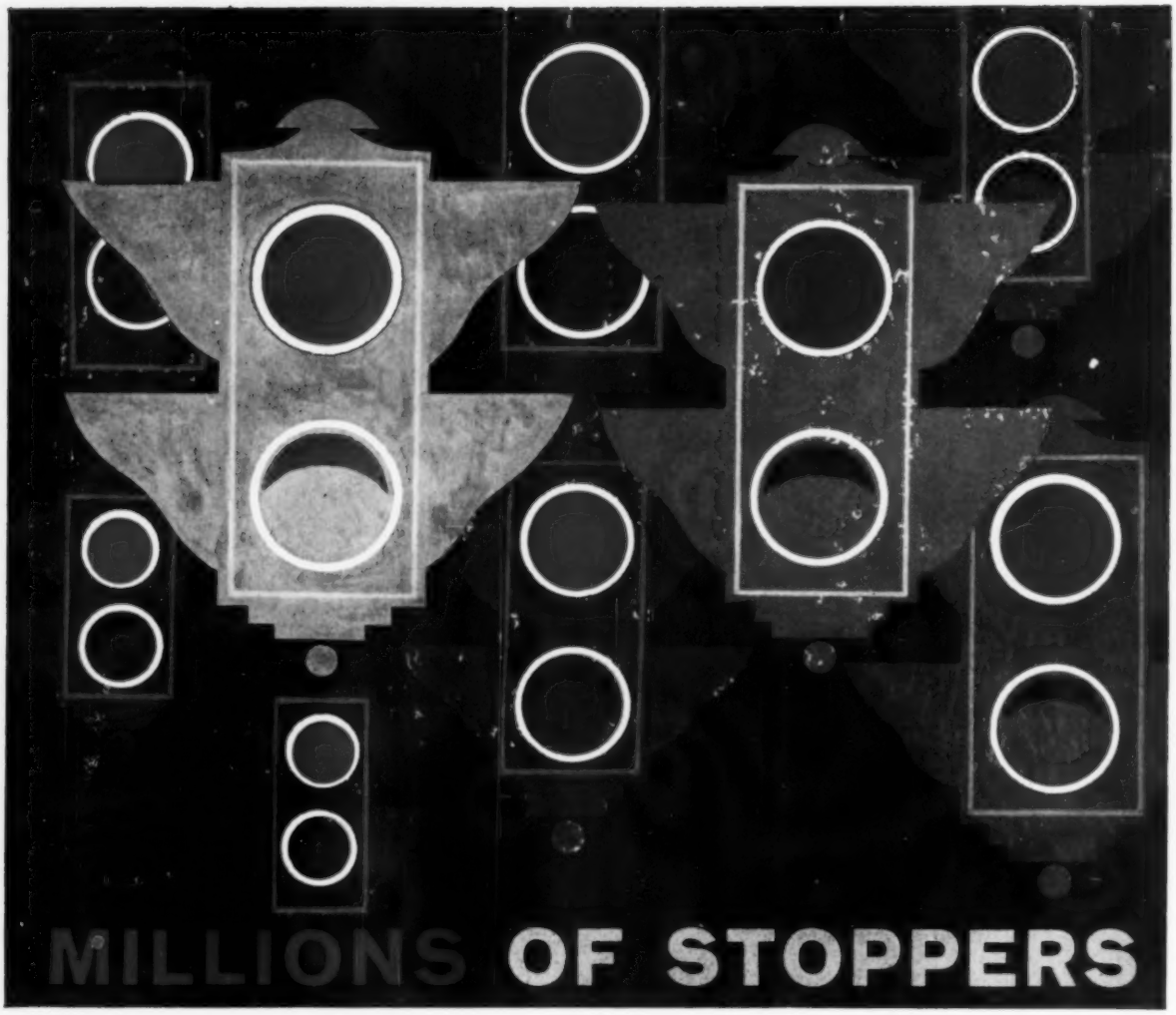
Be sure . . . specify

REED SUPER SHRINK-GRIP tool joints



against fluid loss . . . thousands of feet below!

Millions of Adomite particles dispersed in a fracturing fluid act like traffic lights. They control fluid loss . . . stopping it by forming a temporary seal over pores of the rock matrix.

This allows a fracturing fluid to be injected at higher rates under greater pressures for an extended, deeper fracture . . . with minimum sanding out. After an Adomite treatment there is no evidence that the formation has ever been sealed. Consider these other important reasons why more producers are *standardizing on Adomite:*

- Obtains larger fractures per volume of treatment, or the same-sized fracture with a lesser volume of fracturing oil.
- Decreases friction loss because of the low viscosity of Adomite-treated fluids.
- Saves transportation costs — because Adomite permits you to use your own crudes.
- Assures acceptance by the pipe line companies for Adomite-treated lease crudes.

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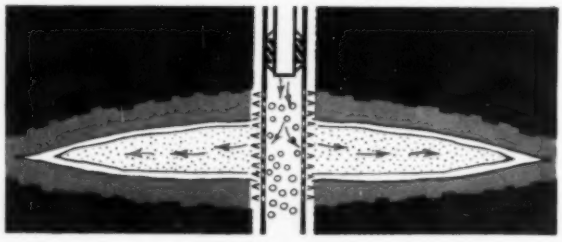

For greater profits
. . . fracture with

ADOMITE®

combined organization will retain the name of exploration and production research division and will be under the direction of **Dr. Noyes D. Smith Jr.,** Shell Development vice president. The new organization will consist of four main groups with **W. R. Purcell** as director of basic research, **J. E. Wilson** as director of exploration research, **B. P. Eastin** as director of production research and **F. Goldstone** as manager of administration and services.

▸ Four new appointments and transfers have been announced by Reading and Bates Offshore Drilling Company, Tulsa. Promoted from vice president to executive vice president is **C. E. Thornton,** whose offices will remain in Tulsa. **George L. Temple,** general manager of the firm at the New Orleans offices, assumes the additional duties of vice president. Formerly at the Calgary office of Reading and Bates, **Frank J. Garnett** has been transferred to New Orleans as assistant to Temple. **N. Glen Watson,** previously with the Oklahoma City offices, has been moved to the Calgary office as assistant to **Steven W. Shambaugh,** vice president and general manager.

▸ **J. R. Brady** has joined Northern Natural Gas Company as reserves engineer in the reserves and availability section of the gas supply department.

▸ **L. C. Stratton,** assistant division production superintendent for Sinclair Oil & Gas Company at Fort Worth, Texas, has been promoted to division production superintendent. He succeeds **John T. Reeves,** who has taken a leave and will retire this year.

▸ **R. E. Clark** has been elected president of Pacific Oil Company (California), a wholly owned subsidiary of Standard Oil Company of California, with headquarters in San Francisco. Clarke succeeds **T. J. Galbraith** who retired March 1 after 38 years of service. In addition to his new job, Clarke will continue as manager of natural gas utilization for Standard.

▸ **Myles C. Marek** has been named area superintendent of Sunray Mid-Continent Oil Company's Placedo McFaddin (Texas) area. Marek replaces veteran superintendent O. C. Dillon who died in February. **Hilmon Mitchell,** formerly junior engineer at Corpus Christi, has been promoted to operating foreman of the Placedo McFaddin area, succeeding Marek.

▸ **Malcom A. Weiss,** has been appointed head of the production research section, a newly-created unit in the process research division of Esso Research and Engineering Company. Prior to his appointment, Weiss was assistant head of his division's cracking section.

▸ **W. Ray Staples,** Dallas petroleum consultant, has been named president of Georesearch, Inc., an oil company with headquarters in the Vaughn Building, Dallas, Texas. Staples has been active in the oil and gas consulting field for a number of years, and has had wide experience in oil property evaluation and operation, with particular emphasis on secondary recovery operations.

▸ **H. Edward Wolf** has been appointed president of the Erie Natural Gas Company, Inc., Erie, Pennsylvania. He has been a financial consultant in recent years serving as a liaison between western oil companies and banking interests in New York and is a founder and director of the Interstate Creditors Association of Denver.

▸ **Ben D. Gould** has assumed duties as chief petroleum engineer and production superintendent for Reiter-Foster Oil Corporation with offices in the Meadows Building, Dallas. Gould was formerly petroleum engineer for American Petrofina Company of Texas. He had previously been employed by Panhandle Oil Corporation, Dallas, and Petroleum Research and Development Corporation, San Antonio.

▸ **Curtis H. Johnson** has opened offices in Los Angeles, California. He joined Reiber Laboratory in 1932 as instrument design and patent engineer, leaving in 1938 as chief geophysicist. He has also served with General Petroleum Corporation (1939-1953) and has been most recently area manager (Europe, Africa, Middle East) of Geophysical Service, Inc.

▸ **Marvin L. McCullough** has been named president of North Texas Oil and Gas Association. He has been an independent oil producer in North Texas since 1937. **R. J. Moran** partner with Moran Bros., Inc., was re-elected as first vice president. **David A. Kimball** named to second vice president and is a partner in Alan Drilling Company. **George W. Anderson Jr.** also was re-elected executive vice president, serving in this position since 1955. He is an attorney.

▸ **R. M. Strom** of Oklahoma City has been named assistant division geologist in Cities Service Oil Company's Mid-Continent exploration division. **J. E. Rakaskas,** district geologist at Wichita, Kansas, will succeed Strom as district geologist at Oklahoma City. **Earl Brandt,** geologist at

(Continued on B-153)

Where drilling is roughest
...here's the GREATEST

SPANG
DRILLING STEMS

With electric-welded, fully heat-treated precision machined box and pin joints.

When the going is tough you'll do better with Spang Drilling Stems. Here's a drilling stem that's distinguished for its greatness . . . greater than average service . . . greater joint strength . . . greater footage at less cost.

Made of machine straightened special bar quality open hearth steel, Spang stems are of the exact analysis to assure the greatest vibration dampening effect. Precision machined threads assure the strongest and most wear-resistant joints obtainable.

SPANG REPLACEMENT BOXES and PINS are available in the same carbon steel analysis as those on the original stems. In all sizes, lengths and joint combinations for forge or electric welding to stems when renewal is required.

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TIA JUANA No. 2...

Twelve I-R Centrifugal Compressors are injecting a maximum of 300,000,000 cu. ft. of gas per day

Located 7 miles offshore on Lake Maracaibo, Creole Petroleum Corporation's second giant gas injection plant—Tia Juana No. 2 is the largest of its type in the world.

Here, twelve Ingersoll-Rand centrifugal compressors, each driven by an 8,000-hp gas turbine, inject a maximum of 300 million cubic feet of gas per day into huge underground oil reservoirs, increasing oil recovery, conserving natural gas and permitting lower production costs by sustaining natural flow. The 12 compressor units are arranged in two six-stage systems operating in parallel, with a final discharge pressure of 1800 psig.

At Creole, the performance of Ingersoll-Rand centrifugals is a matter of record. Ten units, with a capacity of 137 million cubic feet per day and discharge pressure of 2,000 psig, have been in virtually continuous operation on Tia Juana No. 1 since its completion in 1954. *And 14 additional Ingersoll-Rand units are now on order for Platform No. 3.*

Whatever your compressor problem, Ingersoll-Rand can supply the unit best suited to the job—centrifugal, reciprocating or axial-flow rotary.

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Bit Lube

E. P. ADDITIVE FOR MUD

INCREASES Bit Bearing Life

More than doubles bit life-- reduces costly round trips

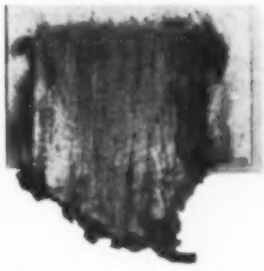
Magcobar's Bit Lube (E.P. Additive for Mud) imparts extreme pressure lubricating properties to drilling mud. It provides the drilling industry for the first time with a means of continuously lubricating bit bearings effectively.

Bit Lube (E.P. Additive for Mud) produces a tough oily film which coats the metal at contact points and provides lubricating properties in the presence of mud far better than conventional mud materials. Bit Lube is an easy to use liquid additive for use in selected types of mud.

Extensive research, backed up by field tests, has shown that bit bearing life is increased from 2 to 5 times. The number of round trips is cut accordingly and drilling costs greatly reduced. Wear on drill pipe and pump parts is decreased and rotating torque is substantially reduced.

Where failure of bit bearings forces bits to be pulled before the cutters are worn, Bit Lube offers an opportunity for saving rig time and lowering overall drilling costs.

Let us help you investigate how Bit Lube can be used in your operations. Mail this coupon for technical literature on Magcobar's Bit Lube.



These photos show the results of tests on a standard lubricant tester using a typical drilling mud. Both test blocks were subjected to an initial load of 50,000 psi and run for 10 minutes on the standard tester. The upper block (lubricated with a typical mud) shows the effect of metal to metal contact. The lower block (same mud with Bit Lube added) shows the polished scar obtained with proper lubrication.

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Parkersburg offers you ONE-STOP pumping unit service through your favorite supply store

Dependable, economical Parkersburg chain-driven and gear-driven pumping units are now available under these famous oil field signs. From these 14 supply companies in the United States and Canada, Parkersburg pumping units are immediately available, regardless of where your location might be.

There is a Parkersburg pumping unit to meet any requirement. Each unit is backed with Parkersburg's guarantee and liberal service policy. And Parkersburg pumping units are world-famous for dependability, economy, and performance.

Gear-driven units are offered through these supply companies in size ranges from 25,000 to 1,500,000 inch pounds peak torque rating. Chain-driven units are furnished with peak torque ratings from 25,000 to 228,000 inch pounds.

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RECTORHEADS

the head that seals with the Ring-of-Steel

More than 125,000 Rector casing head installations prove that you can forget about pressure leaks when your well is equipped with Rectorheads. For working pressures to 15,000 psi . . . regardless of temperature extremes . . . the Rector ring-of-steel provides a lifetime seal.

There is no resilient packing to flow under pressure or deteriorate from heat or time. The casing is welded to a steel ring that fits in a precision ground seat. There is no stress on the weld when the flange bolts are tightened. A steel API ring gasket completes the permanent, maintenance-free seal.

For well safety and long range economy, specify RECTORHEADS . . . now in sizes through 20". Order from your favorite SUPPLY STORE.

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B-152

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Oklahoma City, will transfer to Wichita as district geologist there. **Frank Cooter** of Midland, Texas, has been named special company representative in Santa Fe, New Mexico, and **E. J. Gemmill** as southwestern division exploration manager for Cities Service.

▸ **Gordon Jackson** has assumed the presidency and active management of Well Completions Incorporated. In his new capacity, he will direct the increased development of Well Completions' air and gas drilling services. He will be located at the head offices of the firm at Denver, Colorado.

Gordon Jackson

O. E. Mechem

▸ **O. E. Mechem** is joining Drilling Analysis Company, Denver, Colorado, as general manager. Mechem has been vice president and Rocky Mountain division manager of Delta Drilling Company for the past ten years. Prior to joining Delta he served in the production, drilling, and engineering departments of Standard of California, and Shell Oil in the United States and numerous foreign operations. **R. W. Eckels** succeeds Mechem as division manager for Delta.

▸ **Fred Grimes** has been transferred from the Oklahoma City offices of Sohio Petroleum Company, to the Tyler, Texas, offices.

▸ **J. Van Lindley** has been named director of development and exploitation of Titan-Tex Drilling and Production Corporation. He was formerly associated with the Ted F. Dunham organization, as president of Lindley Drilling Co., Ltd., president of D. P. L. Co., Inc., and production manager of Ted F. Dunham Co.

▸ **R. H. (Harvey) Richardson** has joined Liberty Drilling Corporation of Houston as vice president and general manager.

▸ **Paul Maxwell Crandall,** Corpus Christi, Texas, has been promoted to the position of comptroller of La Gloria Oil and Gas Company. He has been serving as La Gloria's assistant comptroller since February 1949. He is filling a post formerly held by **B. F. Harrison.**

▸ **George T. Hansen,** founder of Utah Southern Oil Company, has announced his retirement as chairman of the company's board of directors and as a director. Hansen served as president of the firm from its beginning in 1921 until his election as chairman of the board in August 1957. At that time he was succeeded as president by **John E. Rouse,** who continues to serve in this position.

▸ **Alfred G. Lewis** has joined Star Falcon Oil Company to manage its operations in Arkansas, Louisiana and Texas. Formerly with affiliates of Standard Oil Company (New Jersey), Lewis' experience includes production, research, engineering, refining, marketing, and employee relations. He expects to establish headquarters in Dallas.

▸ **J. L. Shea Jr.,** division superintendent of drilling and production, Louisiana division of The Texas Company's domestic producing department, has been promoted to assistant division manager, replacing **S. T. McCardell,** who was promoted to assistant general manager of the domestic producing department and transferred to Houston.

Tom Gaines has been appointed assistant manager of Texas Petroleum Company's Colombian producing division, at Bogota. Texpet is a wholly-owned Texaco subsidiary. Gaines was formerly chief petroleum engineer of Texaco Exploration Company, Calgary, Canada, another Texaco wholly-owned subsidiary. He has been succeeded at Calgary by **B. M. Woofter,** formerly assistant chief petroleum engineer. **Fielder A. Jones,** formerly superintendent of Texaco's Pacific Coast pipe lines division, Los Angeles, has been appointed assistant manager (pipe lines) of Texpet's Venezuelan producing division, with headquarters in Caracas, Venezuela. He is in charge of pipeline operations in both Venezuela and Colombia.

▸ **W. C. Tillett** has been promoted to manager, exploration contracts, of Tennessee Gas Transmission Company. Tillett formerly was district exploration manager of the Bellaire, Texas, district. In his new post, Tillett is responsible for coordination of the preparation, approval, execution and distribution of all agreements affecting leasehold, mineral or fee properties owned by the company and administered by the exploration department. He has moved his offices from Bellaire to Houston.

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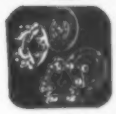
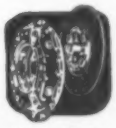
LONG LIFE
Heavy-Duty
POWER
TAKE-
OFF

GIVES CHOICE of CLUTCH TYPES

No Pilot Bearing
Once-a-Year Lubrication
40,000 Hour Main Bearing
5,000 Pound Belt Loads
No Out-Board Bearings


Small Spring Loaded


Heavy Duty Spring Loaded

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Heavy Duty Over Center

Power Take-Offs

Speed Reducers

ROCKFORD Oil Field type POWER TAKE-OFFS are furnished with single or double plate, gear tooth drive clutches—with organic or Morlife® cerametalic friction material. A single plate Morlife clutch provides the torque capacity of a double plate organic lined clutch. Morlife's 400% longer life and 50% better heat disbursal also increase the efficiency of oil field equipment.

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Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

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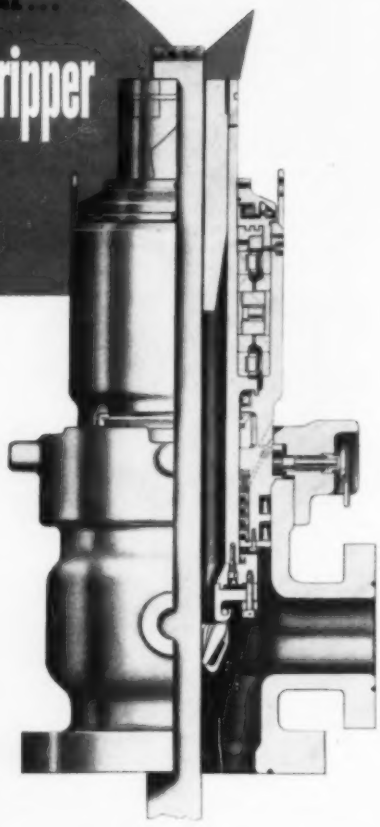
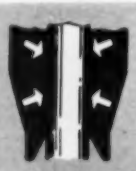
WHENEVER you're drilling in unknown formations—or in troublesome zones where pressures are a problem—make sure you install the unequalled protection you get with the Shaffer Rotating Blowout Preventer and Stripper.

HERE'S a unit that maintains *continuous* pressure control as long as the drill string is in the hole—whether the string is rotating, is being raised or lowered, or remains stationary. Since pressure control is continuous, emergencies can't happen too fast for this unit, because it is *always* sealed off around the drill string until the string is removed from the well. Note the many unusual features as outlined below...

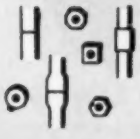


Note space-saving compactness. Even flow-line connections are built-in, eliminating need for spools.



PRESSURE SEAL IS CONTINUOUS—not only while running the varying shapes of the drill string in and out of the hole, but also during rotation and while pipe is stationary. Moreover, the sealing unit automatically adjusts itself to maintain its seal. No manual operations are necessary!

PROTECTIVE STEEL BARRIER of flexible latches protects the Stripper Rubber against damage as varying shapes and diameters pass through the unit. This flexible steel barrier also protects the Rubber from extruding under high well pressures!



SEALS VARYING DIAMETERS AND SHAPES because the Stripper Rubber *automatically* expands and contracts to maintain a pressure-tight seal around the elements in the drill string—the varying diameters of flush, upset and coupled pipe, drill collars, subs, etc. ... and any shape kelly, whether square, hexagon or octagon!

SEPARATE THRUST AND RADIAL BEARINGS carry all rotating loads, assuring maximum efficiency under any combination of horizontal and vertical loads. And since the Stripper Rubber rotates *with* the kelly—not around it—wear and flexing of the Rubber is negligible and the seal remains pressure-tight!

LARGE DIAMETER TOOLS, such as bits, reamers, etc., are easily passed through the unit by simply rotating the Bonnet 1/6 turn. This unlocks the internal mechanism so that any equipment that passes through the casing will also pass through the unit.

See the Shaffer Section of your Composite Catalog.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6201 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
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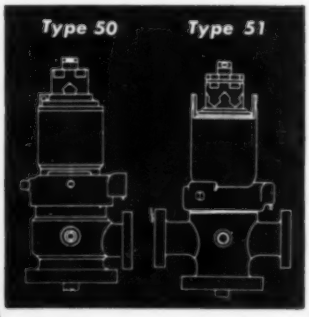
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

35 years OF OIL TOOL LEADERSHIP

Send for the latest Shaffer Catalog. It's free!



Available In Two Types:

Type 50 is for drilling through 10¾" Casing or larger.

Type 51 is for slim-hole drilling, drilling-in, production and re-work operations.

Both types have the same basic design advantages!

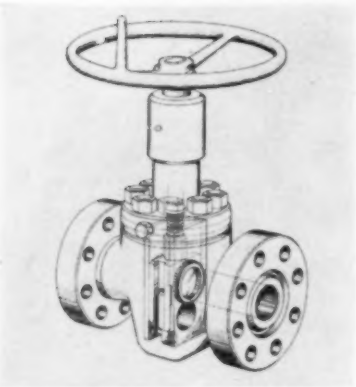
Our nearest Shaffer representative will gladly supply full details. Or write direct!

It's New

Drilling – Producing Equipment

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Cameron Introduces New Gate Valve



Two high strength alloy steel rings that rotate a fraction of a turn each time the gate is opened are the principal feature of the new Type "F" conduit gate valve being made by Cameron Iron Works, Inc. This rotating seat feature increases the life of the gate valve many times.

Rotation of steel seat rings exposes fresh metal to the erosive blast of line fluids during the time just as the port in the gate is uncovered on opening, or as the flow is being pinched off on closing. Wear is distributed over the entire sealing surface of the steel seat rings instead of being confined to a small area at the bottom of the seat.

The valve also features a conduit type gate design, through-bored to provide a smooth flow-way in the open position.

A non-rising stem operates the gate and eliminates the need for a lower stuffing box. The stem is held to the stem adaptor by a pin so sized that if an overload torque is inadvertantly applied to the hand wheel, the pin will shear before the stem or other internal parts are injured. The stem is also equipped with a shoulder which may be jammed against a seat in the bonnet flange to seal off the stuffing box and permit changing stem packing while the valve is still under pressure.

The gate is of 1-piece construction which helps prevent line sediment from entering the body cavity and also makes it impossible to pressure lock the valve when the upstream pressure is bled off.

The gate valves are presently available with screwed or flanged ring joint connections and are also available in special body construction for dual and triple completion applications. *Cameron Iron Works, Inc.*

Circle number (1) on reply card.

Liquid Level Sensor

A liquid level sensor which utilizes a radioactive material in the sensing element has been introduced by the Robertshaw-Fulton Controls Company. Designed to provide an actuating signal to control or indicate a predetermined level, the unit consists of a small sensing probe that may be connected by up to 200 ft of cable to an amplifier.

A permanently sealed source of beta radiation and a beta-ray detector tube are mounted in the probe, separated by a space open to the liquid. When the probe position is encountered by the liquid, beta radiation is absorbed by the material, reducing the pulse rate at the detector to a level which operates a relay. *Robertshaw-Fulton Controls Company.*

Circle number (2) on reply card.

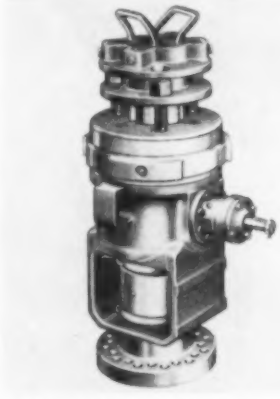
Open Side Vise

Baker Oil Tools, Inc., has developed a screw-type, open side vise with a range of from 2⅜ to 8⅝ in. designed to hold tubular goods as well as irregular pieces such as valves or manifolds. The side-opening feature permits insertion of objects into the vise from 3 sides. The lower jaw of the 1-piece, cast steel body is slotted to accommodate 4 hard dies which will stand a maximum of rough usage. New dies can be installed quickly. *Baker Oil Tools, Inc.*

Circle number (3) on reply card.

Rotating Drilling Head

The Guiberson Corporation has announced a new rotating drilling head for well servicing and completion work, slim-hole drilling and air or gas drilling.

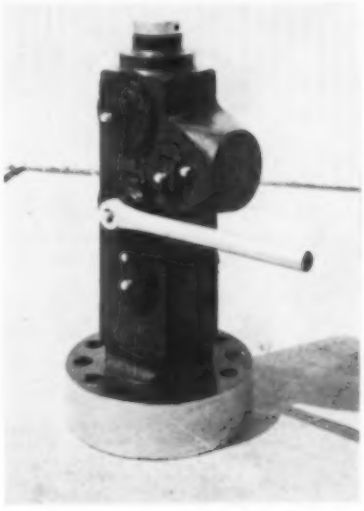


The head has a built-in rotary table with unitized slips and heat-treated kelly drive bushings. Rubbers are available to pack off on pipe sizes of ¾ in. through 3 in. The head has a 4⅞-in. opening through the head with rubber removed and will accommodate a 3 in. square kelly. *The Guiberson Corporation.*

Circle number (4) on reply card.

Unitized Christmas Tree

The Oil Center Tool Company has developed a well completion tree incorporating a new concept in such units. Known as the UNITREE, the unit features "built-in" valves which eliminates numerous joints and flanges, resulting in a substantial decrease in size and weight of the tree. Reduction of joints and flanges also minimizes leakage hazards.



The first tree, designed for single completions, is only 43 in. high and can replace a Christmas tree 12 or 13 ft high. The units are available for 2⅜-in. API and 2⅞-in. API tubing in series up to 30,000 psi test. *Oil Center Tool Company.*

Circle number (5) on reply card.

Expanded Diesel Engine Line

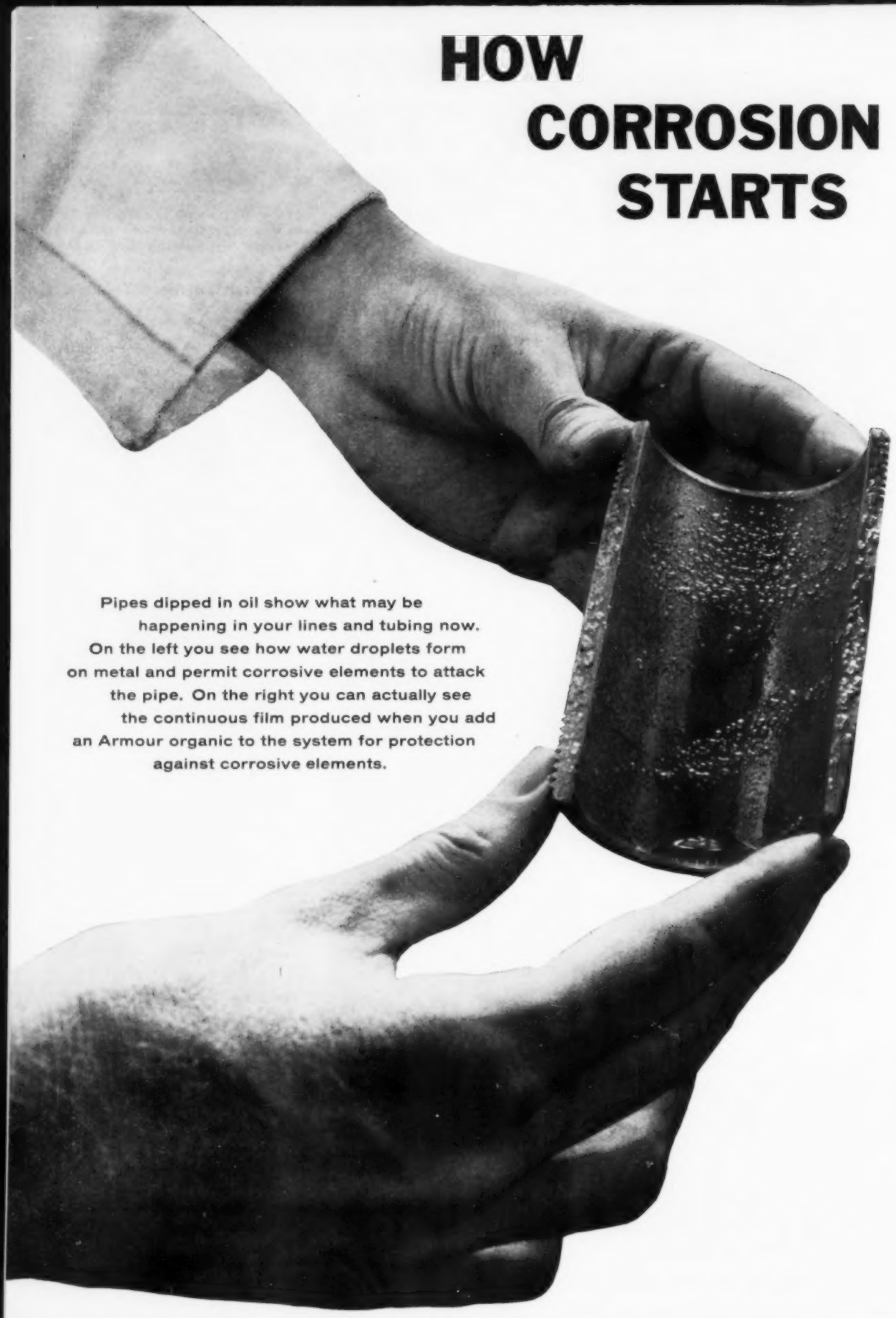
Two new diesel power units have been added to the engine line of Allis-Chalmers Manufacturing. They are the 88-hp model D-344, and the 131-hp model D-516 units. The high-torque engines provide a steady horsepower output at practical working speeds from 1000 to 1800 rpm. Full pressure lubrication and thermostatically controlled cooling systems provide smooth, safe operation and long engine life.

The overall width of both models is 33 in. Length of the 4-cylinder D-344 from radiator to clutch is 64¾ in. and the 6-cylinder D-516 is 80 7/16 in. *Allis-Chalmers Manufacturing Company.*

Circle number (6) on reply card.

(For more Equipment News, see Page B-159.)

HOW CORROSION STARTS



Pipes dipped in oil show what may be happening in your lines and tubing now. On the left you see how water droplets form on metal and permit corrosive elements to attack the pipe. On the right you can actually see the continuous film produced when you add an Armour organic to the system for protection against corrosive elements.

HOW ARMOUR ORGANICS STOP IT

Duomeens® and Arquads® form continuous films. They lock out water and corrosive elements—give up to 99.5% protection.

In primary and secondary oil recovery operations, Armour organic chemicals offer unmatched protection against corrosion. As little as 10 ppm protects pipes and equipment—above and below ground.

Duomeens and Arquads protect against the corrosive effects of brine, hydrogen-sulfide and other corrosive elements. Because they adsorb continuously on metallic surfaces, Armour organic chemicals are lengthening the life of pipes and equipment, and cutting replacement costs in many oil fields.

• • •

There are variations of these basic Armour inhibitors. Each has characteristics useful in specific applications. They are effective at about 10 ppm in water-flooding, or at about 50 ppm when used as down-the-hole inhibitors, (basis: 100% activity).

Duomeen CD-50: Effective corrosion inhibitor in all water systems. Completely dispersible in water. **Duomeen CDA-50:** Used in systems where carbon dioxide and oxygen corrosion are a problem. Water soluble. **Arquad T-2C:** Particularly effective in fresh water systems. Ranges from water soluble to dispersible. **Armac CD-50:** Especially effective in fresh water systems and low sulphate brines. **Duomeen TDO-50 (Liquid):** An easy to use, oil soluble, water dispersible, down-the-hole corrosion inhibitor. Utilized to inhibit corrosion in salt water disposal systems. **Duomeen TDO (Fluid paste):** 100% active, oil soluble corrosion inhibitor, also used in salt water disposal systems.

Duomeen TDO under varied test conditions

	Control	With Additive	Gals. per 1,000 bbls.**
ASTM Turbine Oil Test	Heavy corrosion	No corrosion	1.7
Revolving Wheel Test H_2S saturated brine-kerosene	39.6 mpy*	3.8 mpy	2.1
Salt Water Disposal System Test Coupons installed at well heads	15 mpy	.5 mpy	0.2

*Mils penetration per year **Basis, 100% Activity

For product samples and descriptive literature on treatment procedures, and applications information for any of these Armour organics, simply write us on your company letterhead.

ARMOUR CHEMICAL DIVISION

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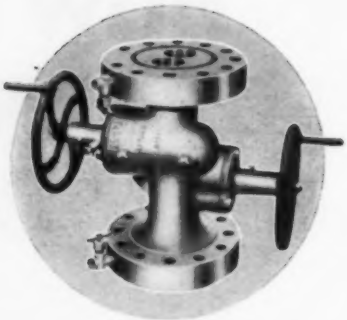
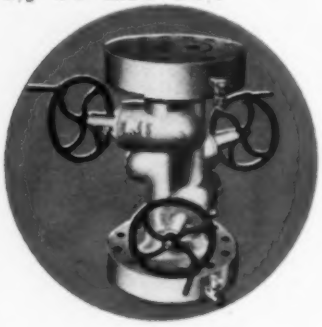
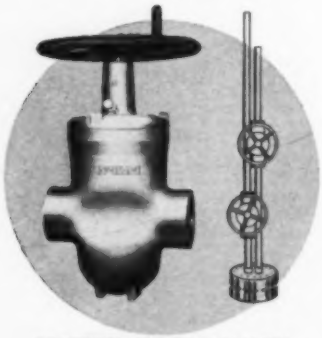
Armour—Leader in progressive fatty acid chemistry



DUAL VALVES
Sizes: 1½" x 1½", 1¾" x 1¾", 2" x 2", 2½" x 2½", 2" x 2½" 2½" x 3" and 3" x 3".



TRIPLE VALVES
Size: 2" x 2" x 2".



RECESSED BODY VALVES
Sizes: 1½", 1¾", 2", 2½" and 3". Right Side or Left Side Recessed as ordered.

The same efficient flow control provided by standard W-K-M Through-Conduit Gate Valves is available for multiple completions with the W-K-M Dual, Triple and Recessed Body Gate Valves.

These valves provide turbulence-free through-conduit flow, W-K-M's exclusive CONTROLLED FORCE SEATING, DOUBLE-TIGHT SEALS* at both upstream and downstream seats and all the other important advantages of W-K-M standard valves.

Specify the W-K-M Dual and Triple Completion Valves for the most efficient trees. Where economy is paramount, specify the W-K-M Recessed Body Valve . . . identical internally with standard W-K-M Valves, but with a body recess to allow the necessary close fit between tubing strings.

W-K-M
DIVISION OF acf INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS
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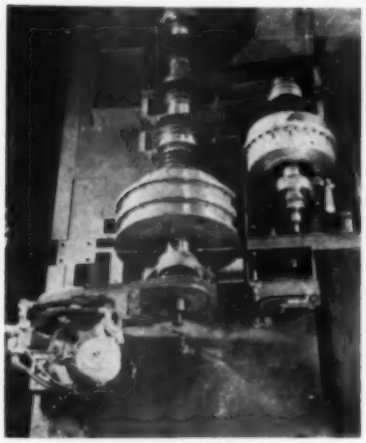
Write Dept. G-5 for Bulletin WP 1057 for full information on W-K-M Valves for multiple completion. For complete details on W-K-M oil field valves, ask for Catalog 200.

MANUFACTURERS OF W-K-M GATE VALVES · ACF LUBRICATED PLUG VALVES · KEY-KAST ALLOY STEEL PIPING FITTINGS · KEY RETURN BENDS AND FITTINGS

5726

Auxiliary Drawworks Drive

An auxiliary drawworks drive that permits the speed of the rotary to be varied to suit drilling requirements, even with all engines in the drive group operated as a single unit to power the slush pumps, has been developed by The National Supply Company. Diverted power can range up to 300 hp maximum.



The drive consists of a fluid coupling mounted on a countershaft on the sectional frame of the No. 1 engine. Power is transmitted to this coupling by means of a chain drive from the front shaft of the drive group. Power from the coupling is transmitted by chain to the drawworks drive quill sprocket on the extension shaft of the front engine. *The National Supply Company.*

Circle number (7) on reply card.

Bottomhole Heater Unit

The Texsteam Corporation has announced a surface heater unit for application in bottomhole heating operations. The 157-lb unit is capable of building surface temperatures to above 450 F, requiring only 450 cu ft per hr of gas delivered to the burner at 1 psi. The unit is also applicable to surface operations such as flowline heating.

Bottomhole heating technique involves pumping hot fluid from the heater through macaroni pipe to bottomhole heat exchangers attached to the production tubing string, then back to the surface through a second macaroni string. *Texsteam Corporation.*

Circle number (8) on reply card.

Torque Tube Viscosimeter

A new torque tube viscosimeter designed as an instrument for continuously measuring and recording the viscosity of liquids in closed systems under pressure has been developed by The Dow Chemical Company. Many of the viscosimeters are used in certain Dow processes. They are not standard equipment but have been made especially for those processes. *The Dow Chemical Company.*

Circle number (9) on reply card.

Flexible Nylon Coupling

The addition of a new, lubrication-free nylon coupling to its line of flexible couplings has been announced by Morse Chain Company. The corrosion-resistant chain element of the coupling is constructed of nylon segments and stainless steel pins. It can be disassembled or connected at any link without special tools.

The coupling handles loads from fractional to 40 hp and speeds from 500 to 5000 rpm. Complete couplings or chain elements are available. *Morse Chain Company.*

Circle number (10) on reply card.

High Pressure LPG Hydrometer

Specific gravity tests on liquefied petroleum gases may be run on a new high pressure hydrometer jar designed by Koehler Instrument Company, Inc. LPG is admitted under pressure into a transparent plastic cylinder which houses a floating hydrometer.

The cylinder withstands working pressures up to 1000 psi, well in excess of the pressure required for testing LPG or other volatile hydrocarbon products. *Koehler Instrument Company, Inc.*

Circle number (11) on reply card.

Rotary-Balanced Pump Jacks

A new line of rotary pump jacks, to be distributed along with the standard beam-balanced line, has been introduced by Jensen Bros. All units of the line are floor-clearing models and can be installed on flat concrete surfaces or steel skids. One man can operate the rack-and-pinion-gear counterbalance system. Main shafts and bearings of the line are heavier than those of the beam-balanced line. *Jensen Bros. Mfg. Co., Inc.*

Circle number (12) on reply card.

Giant Offshore Spudding Shoe

A special 30-in. guide shoe for spudding in offshore locations with big savings in time has been developed by Rector Well Equipment Company. The shoe, butt-welded to a 220-ft string of casing and operated from a crane barge, uses the jetting action of water forced through holes in the aluminum nose to speed up drilling the conductor string hole through the silt that covers the floor of the Gulf of Mexico. Sand and silt packing back around the casing eliminates the necessity of cementing the string. *Rector Well Equipment Company.*

Circle number (13) on reply card.

Shot-Peening Increases Oil Tool Life . . .

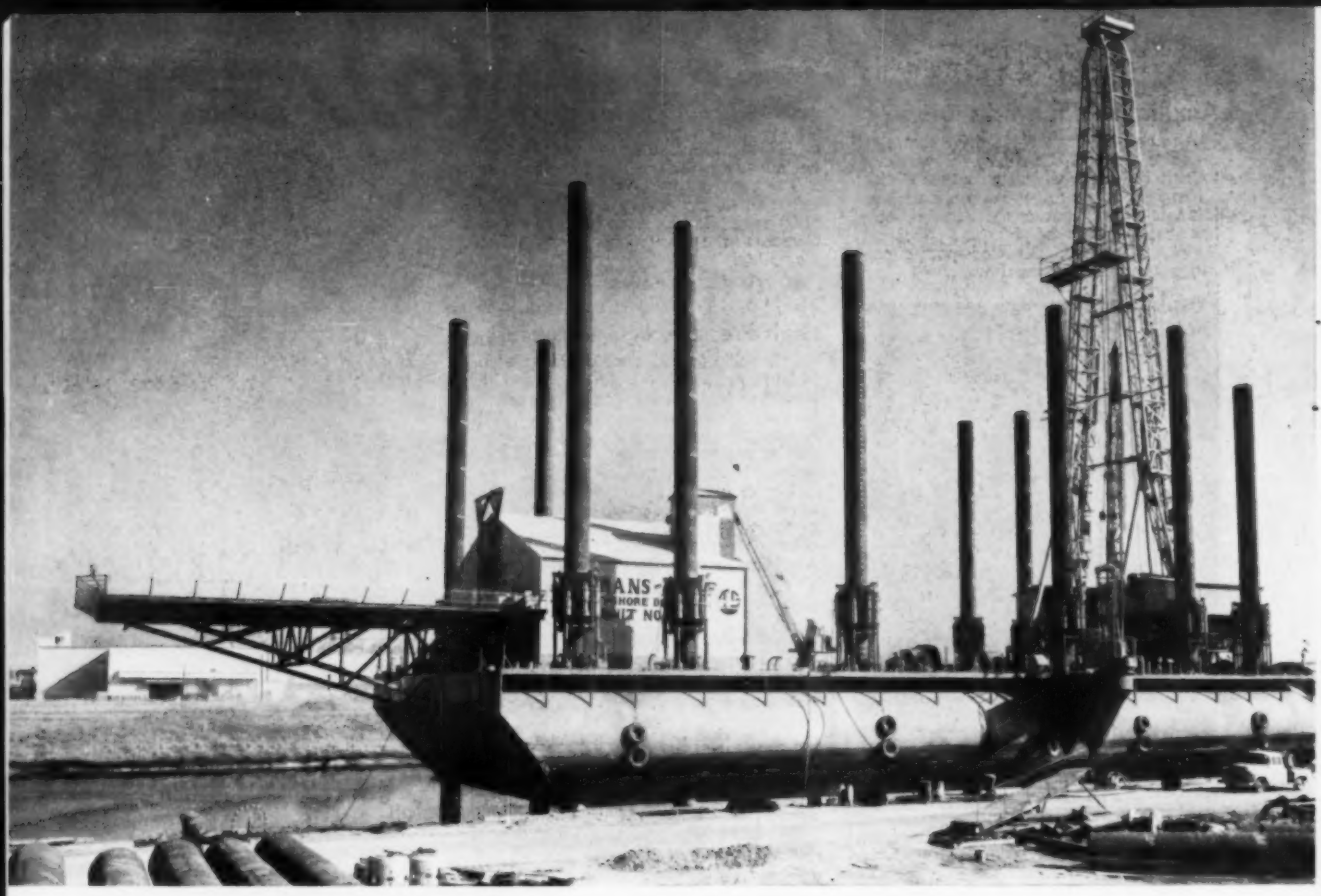
. . . in a production process used by the drilltrol Corporation in the manufacture of its drillable wing stabilizer. A company spokesman says that the stabilizer's resistance to tension has been greatly increased by the shot-peening process.

The operation performed by the Metal Improvement Company of Los Angeles gives added endurance by firing fine, round shot at the metal, beating the surface into a more compressed layer. For approximately 20 minutes, the wing pockets of the stabilizer's alloy steel body are hammered by 0.028 gage pellets, fired at about ⅓ the muzzle velocity of a .45 revolver blast. The process results in an increase of tensile strength in the metal skin of around 60,000 psi.

The drilltrol Corporation considers that the added strength of the stabilizer extends the basic capabilities of the tool in vertical and directional drilling as fulcrums, hole straighteners, key seat guides, and preventatives for pressure differential sticking.

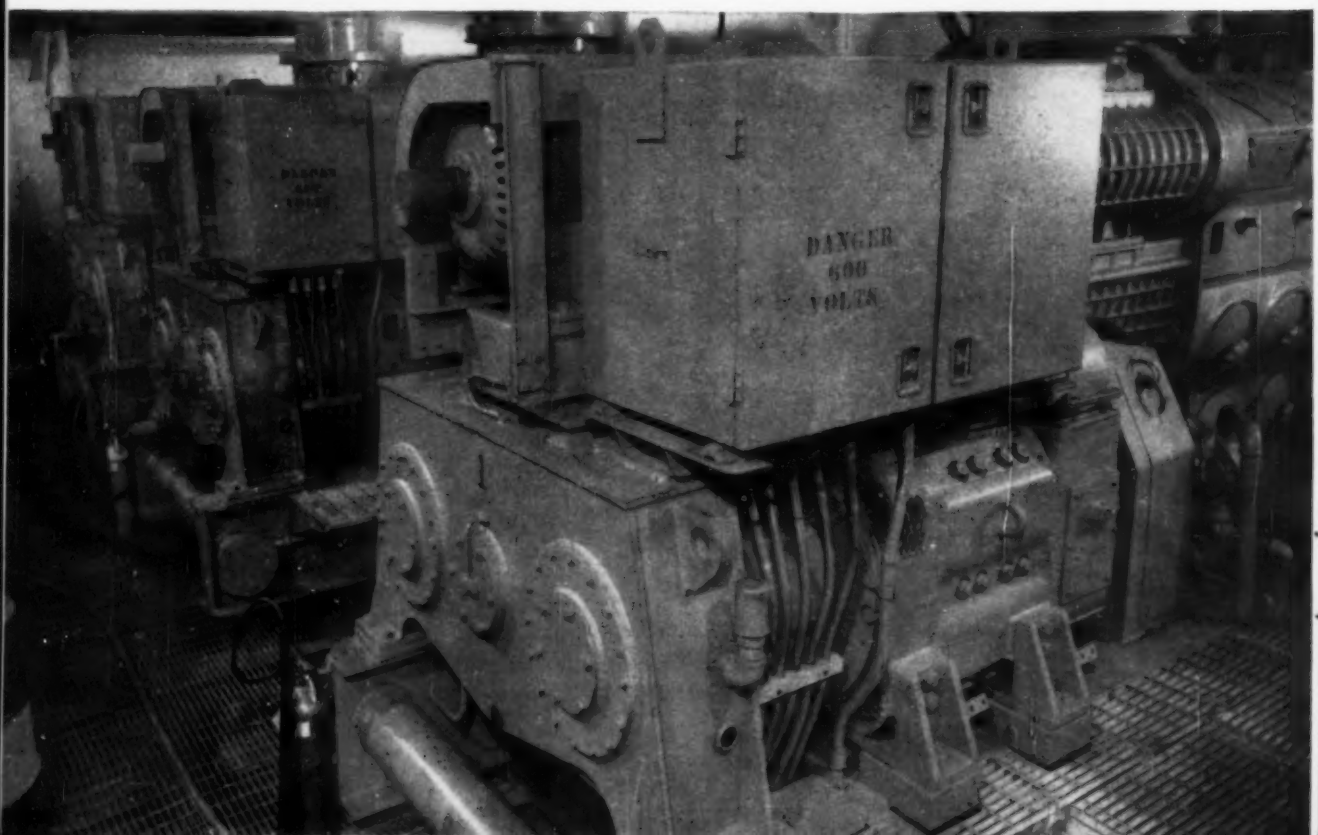
Drillable wing stabilizer manufactured by the drilltrol Corporation is shot-peened in a process developed to increase the tensile strength of the tool.

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD



The huge mast on Trans-Gulf's new mobile rig towers 143 feet above the deck. Hydraulically operated legs, each 210 feet long, permit drilling in 75 feet of water. A two-story crew quarters is located on the bow main deck.

Three Electro-Motive engine generator sets of 1000-hp are located in the hull which leaves the deck clear of power equipment. Mud pumps, each powered by two 625-hp electric drive motors are also located below deck.



TRANS-GULF RIG No. 10 is Electro-Motive Powered

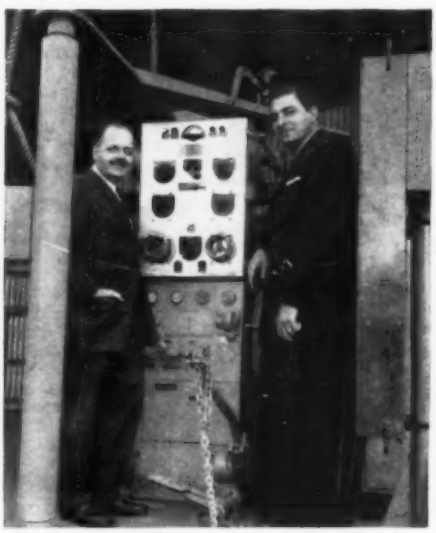
Trans-Gulf No. 10 ranks among the largest rigs in drilling capacity—25,000 feet. Yet, by offshore measurements it is very compact, a design that was accomplished by placing major power equipment in the hull. High cost deck space was held to a minimum without sacrifice of drilling efficiency or accommodations for the crew of forty-two. Deck measures only 87 by 185 feet.

In both control and design, Electro-Motive Power provided cost-saving answers for Trans-Gulf. The standardized components of this power system give complete freedom of equipment arrangement. Standardization also means simplified engineering. You have only *one* manufacturing responsibility for *both* electrical and mechanical components on installation and for service.

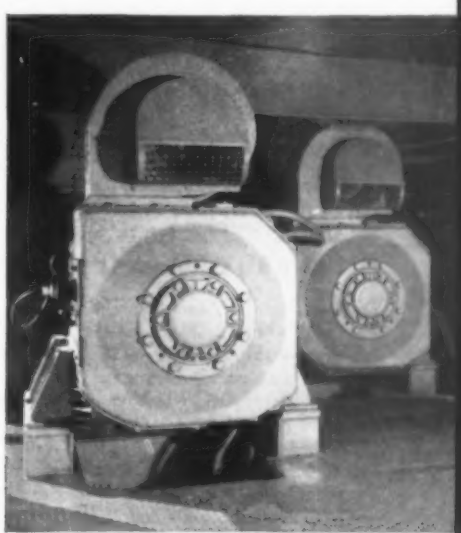
ELECTRO-MOTIVE DIVISION · GENERAL MOTORS

LA GRANGE, ILLINOIS • *In Canada:* General Motors Diesel Limited, London, Ontario

Petroleum industry sales offices: Dallas, Houston, Texas; New Orleans, Louisiana; Los Angeles, California



Inspecting the control console at the driller's station is William Flynn, (right), Vice President of Trans-Gulf. With him is Electro-Motive representative Art Hazell.



Two of the three 625-hp electric drive motors for the big 2500-hp IDECO draw works are shown in their mountings underneath the hoist. This unique arrangement conserves valuable deck space.

Drilling-Producing Literature

Magnetic Power Transmitter

An 8-page bulletin published by the Whitney Chain Company describes the Whitney-Tormag magnetic drive. This power transmitter consists of a magnetic rotor, which is a cylinder to which are attached permanent magnets, and a bi-metallic rotor, which is a copper-faced mild steel cylinder perforated with steel rivets. The magnetic cylinder, rotating inside the bi-metallic cylinder with an air gap separating the two, induces a controlled torque through eddy currents, with the permanent magnets supplying the necessary flux. The drive is offered initially in a range from 1 to 15 hp. *Whitney Chain Company.*

Circle number (14) on reply card.

Buttress Thread Casing

Jones & Laughlin Steel Corporation has issued an 8-page brochure describing buttress thread casing. This casing offers the exceptionally high strength necessary for deep, high-pressure wells now being drilled. Application, manufacturing data and specifications of the casing are covered fully in the pamphlet. *Jones & Laughlin Steel Corporation.*

Circle number (15) on reply card.

Grooved-End Pipe Coupling

Victaulic Company of America has prepared a new 6-page illustrated bulletin describing the "Vic-Easy" method of quick-coupling lightweight pipe or tubing. The bulletin details installation and operating features and illustrates typical applications. Drawings show how the couplings lock grooved pipe ends to form a positive seal under pressure or vacuum and how the design permits quick disassembly. *Victaulic Company of America.*

Circle number (16) on reply card.

Scale Control Bulletin

Calgon 15-J, a controlled solubility phosphate used in the down-hole treatment of producing oil wells, is described in a new bulletin available from Calgon Company. The new literature points out 15-J is specially formulated physically and chemically to prevent precipitation of calcium carbonate, calcium sulfate and barium sulfate in the well-bore and on down-hole pumping equipment. Complete solubility data and recommended dosages for combating various scale conditions are contained in the bulletin. *Calgon Company.*

Circle number (17) on reply card.

High Pressure Screw Pumps

Warren Pumps, Inc., has published a bulletin which features the company's high pressure screw pumps for various oil services at discharge pressure to 1000 psig and viscosities from 35 to 75,000 SSU. Selection nomographs, outline dimensions, sectional view and details of design and construction are included in the bulletin. *Warren Pumps, Inc.*

Circle number (18) on reply card.

High Volume Producer Pump

Fluid Packed Pump Company announces a new 4-page illustrated bulletin on the OILMASTER high volume producer pump. The bulletin covers operations details and includes specifications and cataloged parts information. *Fluid Packed Pump Company.*

Circle number (19) on reply card.

Dual String Wellheads

Dual string wellhead equipment for working pressures up to 3000 and 5000 psi is described in Bulletin No. 480 of the National Supply Company. Complete descriptions and specifications of 5 types of equipment are offered in this 12-page bulletin for various requirements or conditions of use. Illustrations include line drawings showing design features. *National Supply Company.*

Circle number (20) on reply card.

Rotary Swivel Specifications

Gray Tool Company has produced a 2-color, 8-page catalog covering the Gray rotary swivel. The catalog includes detail drawings of the swivel and lists ratings, lubrication and maintenance procedures, parts lists and prices. *Gray Tool Company.*

Circle number (21) on reply card.

Hydraulic Hand Pump

Baker Oil Tools, Inc., has published a brochure describing their hydraulic hand pump for all types of high and low pressure uses. Pressure up to 6000 psi can be developed and held without undue exertion or danger to the operator.

The brochure describes many applications of the pump in oilfield usage, operating procedure, a schematic drawing of the pump, and a parts and equipment list. *Baker Oil Tools, Inc.*

Circle number (22) on reply card.

Centrifugal Compressors

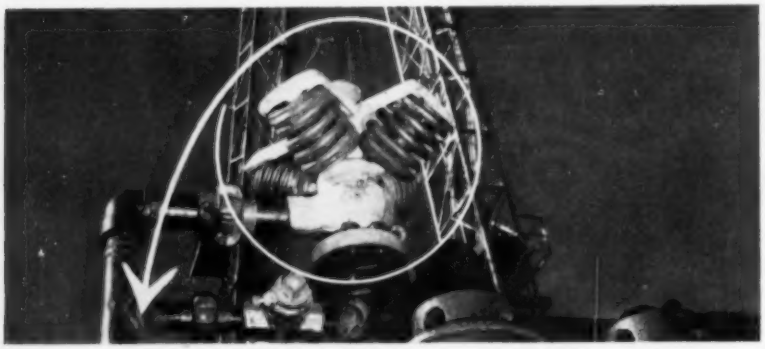
Detailed engineering data and performance characteristics, and a guide to writing specifications, are sections of a new centrifugal compressor catalog being offered by Clark Bros. Company. The 64-page, illustrated catalog includes an introduction to centrifugal compressor features and applications, sections on horizontally and vertically split compressors, and a general section dealing with compressor fundamentals, parts, drivers, engineering data and specifications. *Clark Bros. Company.*

Circle number (23) on reply card.

Flange Dimension Book

The Oil Center Tool Company has published a 15-page flange dimension reference book which is based on tentative API Standard 6B, fifth edition. *Oil Center Tool Company.*

Circle number (24) on reply card.



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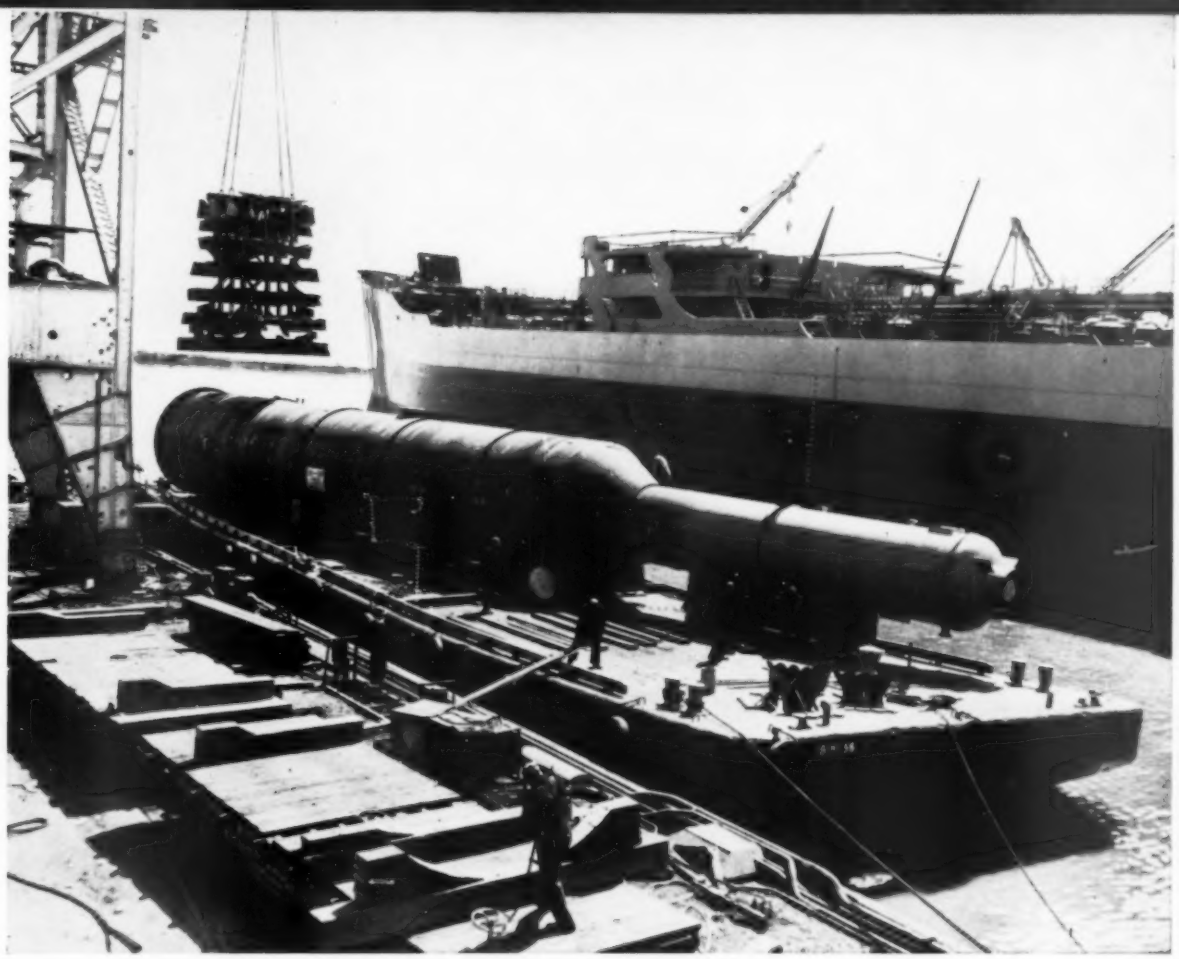

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New Projects in refining gas processing petrochemicals

Cities Service Oil Company has purchased the world's largest shop-fabricated fractionator. Tower, built by Wyatt Metal and Boiler Works in Houston, measures 208½ ft long and will be used for handling overhead streams at the refinery. Tellepsen Petro-Chem Constructors will make the installation at the Lake Charles, Louisiana, refinery.

Japanese Synthetic Rubber Company, Ltd., has been licensed to build a Houdry dehydrogenation unit in the Yokkaichi area. Unit will produce 25,000 tons per year of butadiene, giving the company a total capacity for 45,000 metric tons annually. Various charge stocks will be used, including refinery butane and butane-butene fractions. Unit is expected to be completed sometime in 1960.

North Star Oil Company, Ltd. has contracted with Procon, Ltd. (Canada) for construction of a combination Platforming-Unifining unit at their St. Boniface, Manitoba, refinery. Designed and licensed by UOP, nominal design capacity of the unit will be 2700 bbl per day.

Continental Oil Company will have a 180,000 lb per hour steam boiler installed at its Lake Charles, Louisiana, refinery. Firing mechanism design will allow the boiler to operate first on conventional fuel and then switch to hot gas turbine exhaust for heating. Forced draft fans will be used with the boiler operating at 610 lb pressure and 750 F. Boiler will use zero hardness water from a new zeolite treater that handles 40,000 gal per hour. Babcock & Wilcox Company is the contractor.

Esso Petroleum Company has obtained approval from the British Government for building a $70 million refinery at Milford Haven, Pembrokeshire, Wales. Proposal originally called for 1000 acres for refinery area but was reduced to 350 acres. Area was reduced due to National Parks Commission objecting to refinery being built on park land. Though substantially still within the Pembrokeshire National Park, approval has been given to start construction.

X-L Refineries, Ltd. will soon complete the first asphalt plant for the Peace River area at Dawson Creek, British Columbia. Production from the unit, rated at 350 bbl per day, will be used for road paving in the immediate area.

Continental Oil Company is now converting a single-reactor reformer at the Billings, Montana, refinery. Unit will be revamped into a full-scale reformer producing 1500 bbl per day of high-octane gasoline components; it was formerly used to produce hydrogen for a hydrodesulfurization unit. Conversion is being done by The Refining Engineering Co.

Olin Mathieson Chemical Corporation will boost sulfuric acid production by 250 percent at their Beaumont, Texas, plant. A 500 ton per day sulfuric acid plant, to operate on refinery spent acids, is now under construction along with a new facility for manufacture of ammonium sulfate. Arthur G. McKee & Company is the contractor.

Empresa Nacional Del Petroleo will soon begin an expansion of their Concon, Chile, refinery. A 24,000 bbl per day atmospheric and vacuum distillation unit, a 12,000 bbl per day fluid cat cracker and gas recovery unit, a 6000 bbl per day catalytic desulfurization and reforming unit, and an 1100 bbl per day alkylation unit will be added to boost refinery capacity by 24,000 bbl per day. Design and engineering will be done by M. W. Kellogg Company with construction handled by ENAP.

British Petroleum Company, (Canada) Ltd. will soon begin construction of a 25,000 bbl per day refinery at Ville d'Anjou, Montreal, Quebec. Main units will include catalytic reforming, catalytic cracking, crude distillation, hydrodesulfurization, and polymerization. Construction is to start within the next six months with completion scheduled for mid-1960 by Lummus Company of Canada, Ltd.

British American Oil Company has started construction of their refinery at Port Moody, British Columbia. Designed for 20,000 bbl per hour capacity, the refinery is scheduled to be completed in November 1958. M. W. Kellogg Company (Canada) is the contractor.

Continental Oil Company has contracted Beckman Instruments, Inc., for the installation of an electronic computer-data processing system at their Ponca City, Oklahoma, refinery. Installation will be used with a catalytic reformer producing 10,000 bbl per day of high-octane gasoline. Production yields and other operating statistics will be computed automatically with a warning given to operators if any of the 100 key operating variables begin to drift.

Aurora Gasoline Company will soon complete an 18,000 bbl per day vacuum distillation unit at its Detroit, Michigan, refinery. Unit will process topped crude to make a gas-oil charge stock and a vacuum-reduced flux oil. Internal design of the unit, by Aurora, will increase asphalt and high-octane gasoline yields and give an improved charge stock for the catalytic cracker. The Refinery Engineering Company is the engineering-construction contractor.

Utah Oil Refining Company is completing the installation of a 140 ton, 100 ft fractionator in its new crude distillation unit at the Salt Lake City refinery. Costing more than $2 million, unit will have a capacity of 35,000 bbl per day. Tower was fabricated by Chicago Bridge & Iron Company and erected by Fluor Corp., Ltd. Completion of the project is scheduled for June 1958.

Ethyl Research takes a new look at octane improvement costs

Latest Study Aimed At Helping Refiners Cut the Cost of Meeting Road Antiknock Requirements

Gasolines tailored to the same Research octane number specification may behave quite differently from one another in today's high-compression automobile engines on the road.

This complicates the refiner's ever-present problem of how to make the best gasolines, at the least cost.

ETHYL Corporation's Refinery Technologists—working with a leading process-development company—recently completed a study of the road performance of 18 premium-gasoline blends of different compositions. Results of this study are available to refiners as a guide in planning octane-improvement methods that offer a bonus in superior road performance.

1960 Refinery Used as Model

All processes and blending schemes compared were those which might be expected in a 1960 refinery. A series of 18 premium-gasoline blends were made up using the following stocks:

1. Light straightrun naphtha
2. Two isomerized light naphthas
3. Light cat-cracked gasoline
4. Three catalytic reformates
5. Butylene alkylate
6. Propylene alkylate
7. Propylene dimer
8. Propylene polymer

The blends compared in Figures 1 and 2 consisted of 40% C_5-C_6 fraction, 40% C_7 catalytic reformate, 20% butylene alkylate, 3.0 ml tetraethyllead, and enough *n*-butane for a 10 lb. Reid vapor pressure. Various process stocks were used for the C_5-C_6 fraction. The desired Research and road octane numbers were attained by changing severity of reforming.

A 7-octane spread was specified between the road rating of each premium blend and the Research rating of the corresponding regular-grade gasoline. Any cost of the addition of tetraethyllead to the regular grade needed to maintain this spread was charged to the cost of the premium blend in all process comparisons.

Fuels Road-Rated in Engines Designed for the Future

Each of the 18 premium blends was road-rated at two tetraethyllead levels in six test cars. Two of the cars were 1957 models. Of the remaining four, three had compression ratios of 11-to-1, and one had a compression ratio of 12-to-1. This range of compression ratios permitted appraisal of the various processing schemes on the basis of satisfying predicted octane-number requirements of future cars.

Research and Road Octane Costs Compared

In Figures 1 and 2, the costs of producing various premium fuels are compared from a zero level based on the cost of the straightrun-reformate-alkylate blend which rated 99 road octane number. The catalytic-reformate portion of this blend rated 98.9 RON at 3.0 ml tetraethyllead.

The isomerization curves are based on processing pentanes and hexanes from light straightrun naphtha and from light reformate. In one case (Isom I), only *n*-pentane was recycled. In the other (Isom II), total recycle produced isopentane and dimethylbutanes, to-

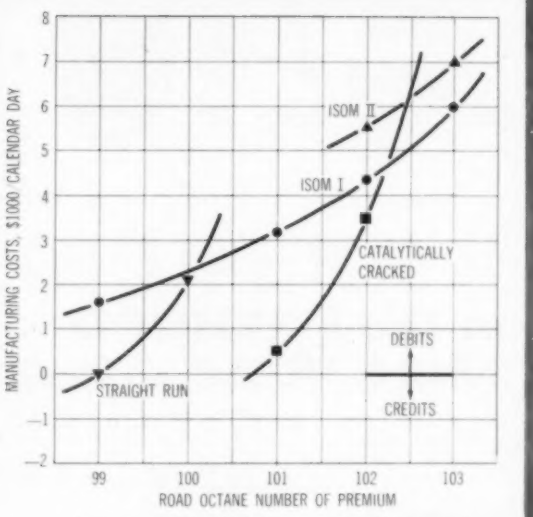

FIGURE 1. MANUFACTURING COST VS. ROAD OCTANE NUMBER OF PREMIUM GASOLINE

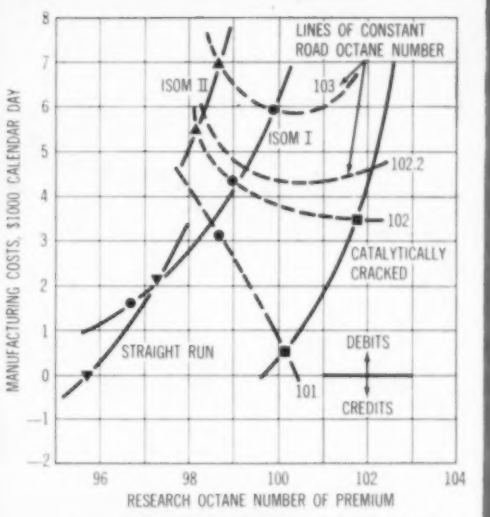

FIGURE 2. MANUFACTURING COST VS. RESEARCH OCTANE NUMBER OF PREMIUM GASOLINE

gether with a minor proportion of methylpentanes and naphthenes.

Choice of Blend Changes Above 102 Road Octane Number

As shown in Figure 1, road performance can be attained at least cost by using a catalytically-cracked C_5-C_6 fraction in premium blends until a road octane number of about 102 is required. Further increases are attained more economically by isomerizing the light straightrun naphtha (Isom I) for blending to premium and diverting the cracked C_5-C_6 fraction to regular-grade gasoline.

At this transition point, calculations from the slopes of the curves indicate that the cost per road octane number barrel is greater than 15 cents with cracked C_5-C_6 fraction in the premium, as compared with about 5 cents using isomerized light straightrun. Beyond this point, Isom I becomes increasingly attractive because it does not require as great increases in reforming severity to attain higher road octane numbers.

Isomerization Improvement Least Costly at High Road Octane Levels

Figure 2 takes both road and Research octane numbers into account. As can be seen, high RON's are obtained at least cost by using a C_5-C_6 fraction from catalytic cracking. However, the lines of constant road octane number show that fuels of the same Research octane rating differ considerably in road performance.

For example, at the 100-RON level, substituting Isom I for light catalytically-cracked stock raises road octane number from 101 to 103.

At a road octane number of 102.2, the two blend types cost the same amount to produce. However, the Research octane number required to satisfy this road requirement is three units lower with Isom I.

Beyond this point, the cost of improving road performance is approximately 7 to 8 cents per Research octane number barrel using isomers, as compared with a cost of 10 to 11 cents using cracked C_5-C_6 fraction.

This study illustrates the importance of analyzing octane-improvement cost on the basis of road antiknock performance rather than laboratory octane numbers alone. Such analysis can improve profits by cutting the cost of meeting actual octane-number requirements on the road.

How Ethyl Research is helping you

Economic studies of octane-improvement processes are a continuing activity of Ethyl's Detroit Research Laboratories.

All of this research is conducted by Ethyl as a service to the Oil Industry—to assist refiners to achieve desired fuel quality and performance at the least possible cost.

The complete report made of this study is available through your Ethyl Representative. Just ask him for a copy of "Road Octane Improvement—A Basis for Process Evaluation."

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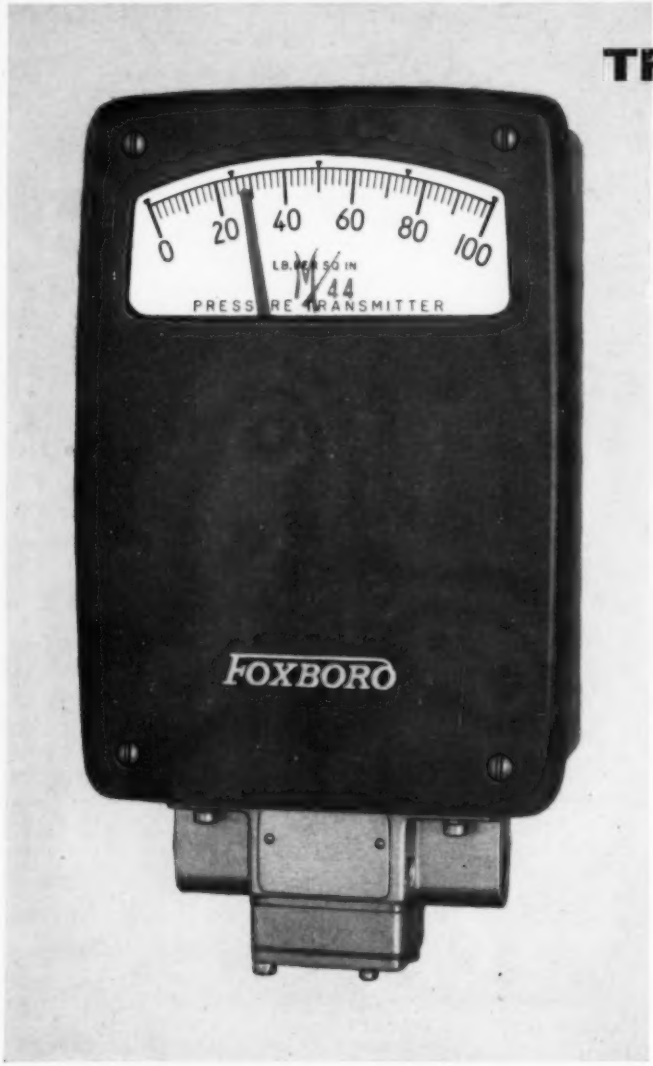

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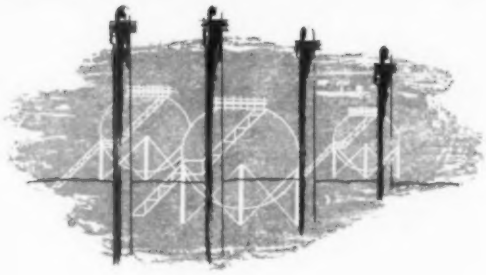


MODERN GASOLINE PLANTS

. . . A Series on Economics, Design, Equipment and Operations

Dave Vondy
Constructive Engineering Company
New Orleans, Louisiana

PART 1. GASOLINE PLANT ECONOMICS

This is the first of an important eleven-part series on gas processing plants installed primarily for recovery of liquids from natural gas. All phases of gas processing will be presented, covering important initial considerations, for building a plant, trends in equipment design and operation, and selection and operation of both new and time-honored processes.

Author Dave Vondy has skillfully combined the general and specific considerations that must be taken into account — types of gas to be processed, cooling water availability, outlets for products and so forth. He has prepared many, many charts and illustrations that will be of full-time value to gas processing technologists and has assembled one of the most complete series on gasoline plants that we have ever seen.

Need for this important new series, to be published exclusively in THE REFINING ENGINEER, is dictated by improved technology and better equipment that enable costs to be minimized. The natural gasoline processor is fighting a continual cost battle; as Fig. 1 illustrates, costs are still increasing more rapidly than is the sale value of products.

It is our desire that this series will help the natural gasoline processor in evaluating proposed and current operations and bring him up-to-date on almost all facets of modern gasoline plant economics, design and operation. Reprints will be available upon completion of the series.

The Editors

ECONOMIC STUDIES are made primarily to evaluate the feasibility of a venture or to enable selection of the best of two or more possibilities. Usually no plant can be installed, a major piece of equipment bought nor a contract let without first justifying the investment with a resulting future return and also eliminating competition with a cost comparison. Past experience will usually narrow the field to a few choices, but final selection requires close examination. Only after all sides of the problem have been examined and alternates show equal merit does it matter which is selected.

A good study must cover all significant factors. Lost time, replacement life, maintenance cost, flexibility and ease of expansion are typical items which are difficult to determine but should be given a monetary value to facilitate rigorous, accurate project evaluation.

How Economic Feasibility is Measured

Percent return on investment, payout time and present net worth are probably the most important economic measurements of feasibility. These are used in a number of different ways, have wide meanings and are not well understood by many persons who could use them as important tools of analysis. Money invested must show a return or it should not have been invested, whether this return is direct or indirect.

Percent retura on investment (which might be termed the earning power of an investment) is used here as that rate at which return on the total investment compounded annually over the life of the project would be equivalent to the net income realized after all costs and income taxes.

Payout is used as the number of years required for the net income after all costs and taxes to total to the initial investment so that at the end of the payout period the money will again be available for investment although it will not have made any profit.

Present net worth will be used as the total value at the time of the investment of all future income less all future costs including a reasonable rate of return on or worth of the money involved.

Curves Show Return Requirement

Dollar return required after costs to realize a percent return on a given investment is shown in Fig. 2. Note that the importance of considering income taxes in an economic study is brought out. Fig. 3 illustrates that a required net income for an investment is significantly influenced by change in return through the life of a project. High early return may make a project feasible while it may not be feasible if the major part of the income is to be deferred for several years. Change in return is usual for gasoline plants; for example, initial product recovery may be high and decline due to decrease in recoverable liquid or recovery may be low for a few years due to operation at reduced capacity.

Present value of future return is illustrated in Fig. 4. The data point out the insignificance of income received toward the end of a project of usual length. It further shows that the value of a return decreases rapidly with increase in percent return on the investment. Thus, if a project having an estimated life of 20 years were to require a 10 percent return, the total of $1 yearly net return through the life would have a present value of $8.50. If a 20 percent return were required, this value would be only $4.90.

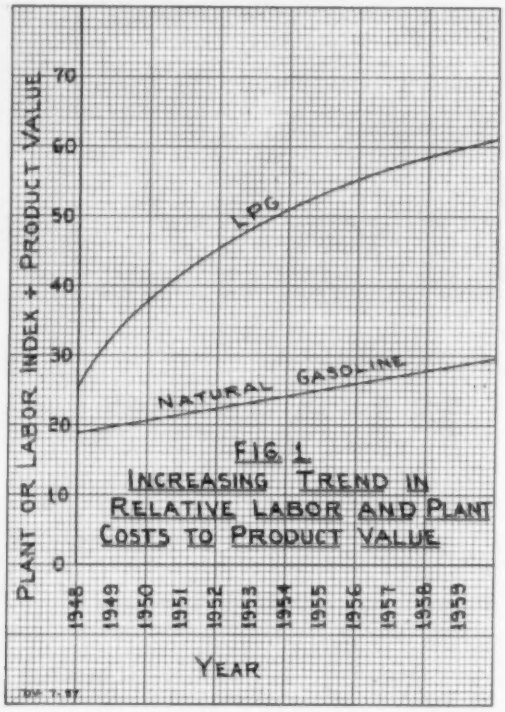


FIG. 1
INCREASING TREND IN RELATIVE LABOR AND PLANT COSTS TO PRODUCT VALUE

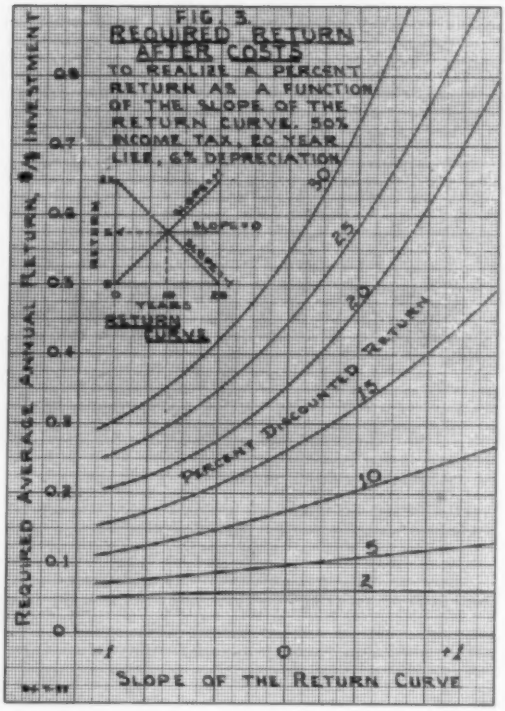


FIG. 3
REQUIRED RETURN AFTER COSTS TO REALIZE A PERCENT RETURN AS A FUNCTION OF THE SLOPE OF THE RETURN CURVE. 50% INCOME TAX, 20 YEAR LIFE, 6% DEPRECIATION

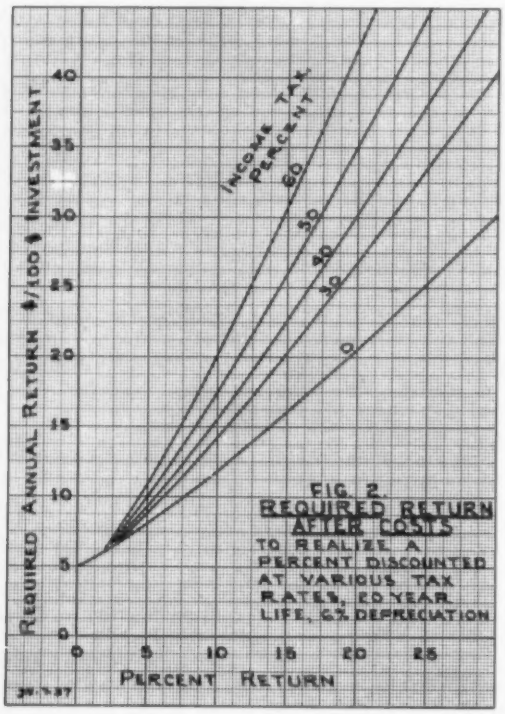


FIG. 2
REQUIRED RETURN AFTER COSTS TO REALIZE A PERCENT DISCOUNTED AT VARIOUS TAX RATES, 20 YEAR LIFE, 6% DEPRECIATION

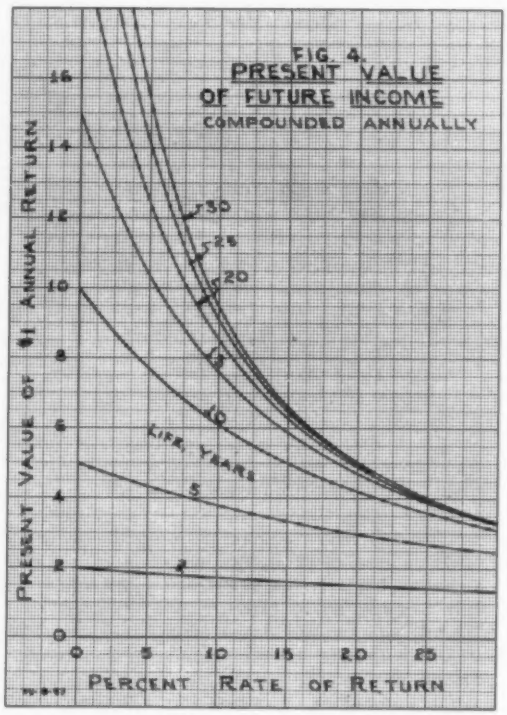


FIG. 4
PRESENT VALUE OF FUTURE INCOME COMPOUNDED ANNUALLY

Minimum Capacity Requirement

Under usual circumstances, the larger the plant the more economical it becomes because of certain fixed costs, installed cost per unit capacity decreases with increase in capacity, and personnel is used more efficiently. Percent return on investment as a function of the amount of gas processed for various liquid contents under defined conditions is plotted in Fig. 5. If six year payout is necessary to justify an investment (16 percent return on the investment), the minimum size plant which can be considered to process C_3 + gas of 0.50 gal per Mcf is 350 MM std cu ft per day. To handle 1.00 gal per Mcf gas would require a 74 MM std cu ft per day plant, smaller plants being uneconomical.

Fig. 6 shows the minimum product recovery required to show a reasonable return on a plant investment for various gas contents. Also illustrated is the effect of operation at re-

duced capacity. Often it is desirable to oversize some equipment in a plant to ease expansion. Items such as fractionating columns and heating systems are very expensive to expand once they are loaded. But, as indicated, excess capacity is costly and difficult to justify.

Gas Value is Important

Value of gas is important in plant economics. For example, Fig. 7 shows that particularly in the case of lean gas, value of plant liquids is very little in relation to the value of

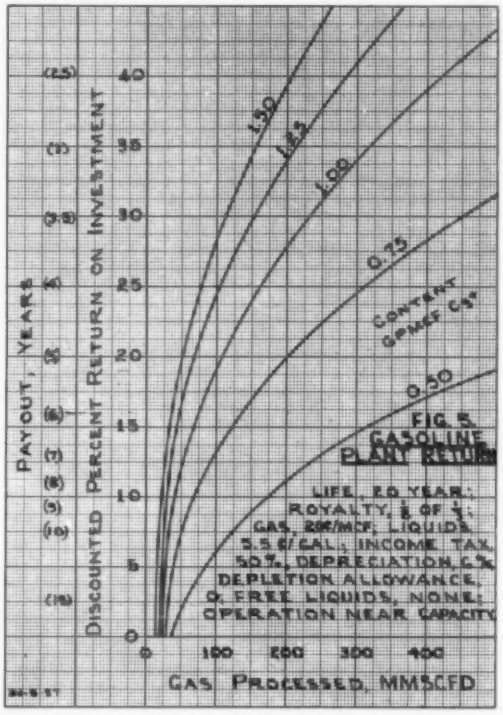

PAYOUT, YEARS
DISCOUNTED PERCENT RETURN ON INVESTMENT
1.50
1.25
1.00
0.75
0.50
CONTENT GPMCF C3+
LIFE, 20 YEAR; ROYALTY, 1/8 OF 1/2; GAS, 20¢/MCF; LIQUIDS, 5.5 ¢/GAL.; INCOME TAX, 50%; DEPRECIATION, 6.5% DEPLETION ALLOWANCE, 0; FREE LIQUIDS, NONE; OPERATION NEAR CAPACITY
GAS PROCESSED, MMSCFD

FIG. 5. GASOLINE PLANT RETURN

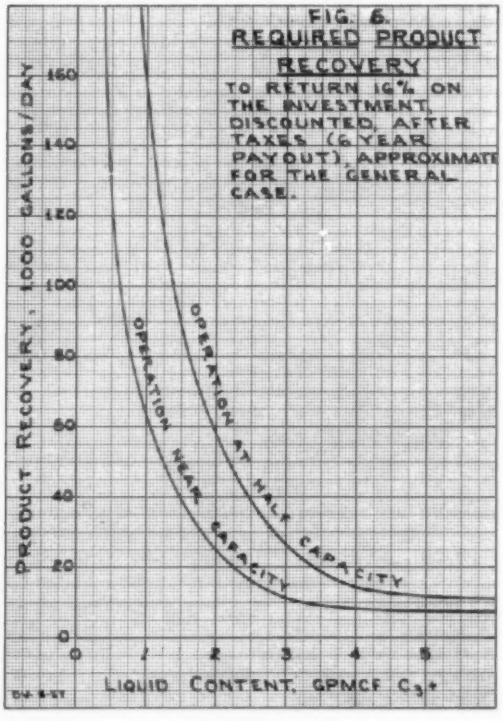


FIG. 6. REQUIRED PRODUCT RECOVERY TO RETURN 16% ON THE INVESTMENT, DISCOUNTED, AFTER TAXES (6 YEAR PAYOUT), APPROXIMATE FOR THE GENERAL CASE.

Dave Vondy *is engaged in engineering work at New Orleans, Louisiana. He formerly worked as a senior production engineer with Continental Oil Company, a development engineer with Delta Tank Manufacturing Company, a process engineer with Tuloma Builders, and a design engineer with Black, Sivalls and Bryson, Inc.*

the gas and decreases significantly as the gas price increases. Plant trouble, installation or expansion should not be allowed to reduce gas delivery significantly.

The value of the gas which must be considered is that at the plant site. If gas is purchased some distance from the site or sold at some location closer to the final market, the cost of pipelining should be considered in the value of the gas when this value is other than purchase or sale price.

A few years ago, it was common for gas to be sold at 5 to 10 cents per Mcf. Recently an offer exceeding 22 cents per Mcf was made for large reserves in South Louisiana. This shows the increase in gas value and points toward a continued price rise.

Fuel and gas shrinkage due to condensation of liquids are inherent costs of a plant operation. Value of shrinkage is shown in Fig. 8. Lighter products cause much more shrinkage and loss in gas revenue than do the heavier fractions. In many situations, high propane recovery can not be justified due to loss in gas for sale, reinjection or other uses.

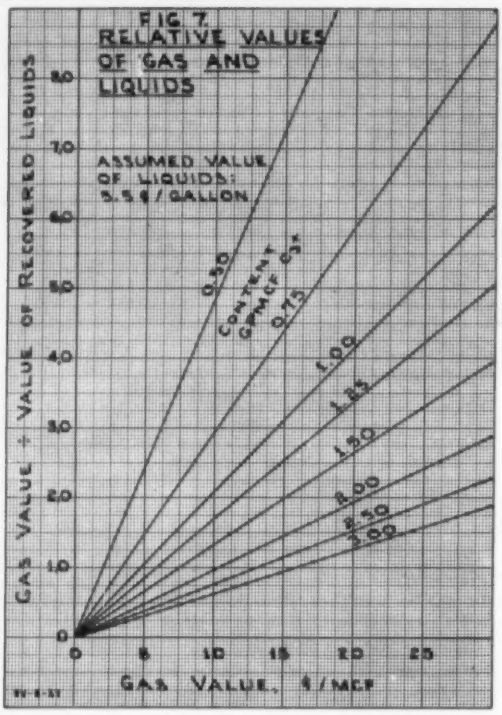
Royalty Payments

Royalty is another factor which reduces the profit from a plant operation. It is normally considered that the owner (lease holder) is entitled to the royalty share of ½ of low-pressure gas compressed and ⅓ of liquids condensed. Often a lease or purchasing agreement makes other provisions or does not cover the processing question leaving a problem of negotiation. Where the royalty is ⅛, the owner may get 1/16 of the gas and 1/24 of the liquids, but return of 3/32 and 1/12 or even more may be necessary.

Propane Recovery

There has been wide belief in the industry that 75 percent propane recovery is the most economical. Many times, plant design specifications have called for 75 percent recovery when this figure was actually uneconomical. Recent trend has been toward setting a practical absorption oil rate and/or refrigeration temperature and designing for efficient retention of propane. Typical oil rates are 10 gal per Mcf at around 80 F and 800 psi or higher, 20 gal per Mcf at around 80 F and 250 psi, and 3 gal per MCF at around 15 F and 900 psi.

The most economical propane recovery is difficult to determine because of the many factors involved. Values of gas and propane, cost of fuel and power, incremental installed plant costs, storage requirement, propane content of gas to plant, predicted change in this content, and the best recovery process must be determined. High recovery can best be accomplished by a different process than low recovery. Generally, the more propane available, the more economical it is to recover a higher amount, up to as much as 95 per-



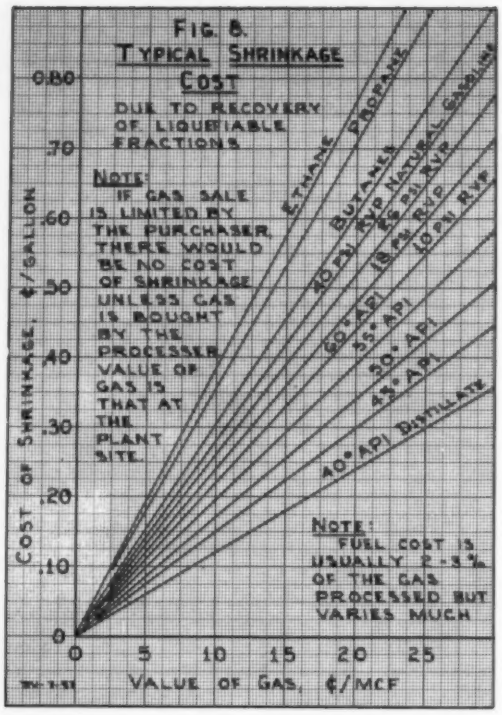


FIG 8.
TYPICAL SHRINKAGE COST
DUE TO RECOVERY OF LIQUEFIABLE FRACTIONS
NOTE:
IF GAS SALE IS LIMITED BY THE PURCHASER, THERE WOULD BE NO COST OF SHRINKAGE UNLESS GAS IS BOUGHT BY THE PROCESSER. VALUE OF GAS IS THAT AT THE PLANT SITE.
ETHANE
PROPANE
BUTANES
40 PSI RVP NATURAL GASOLINE
35 PSI RVP
18 PSI RVP
10 PSI RVP
60° API
55° API
50° API
43° API
40° API DISTILLATE
NOTE:
FUEL COST IS USUALLY 2-3% OF THE GAS PROCESSED BUT VARIES MUCH
COST OF SHRINKAGE, ¢/GALLON
VALUE OF GAS, ¢/MCF

cent. If the content is less than 1.0 gal per Mcf, recovery of more than 50 percent will often not be practical.

Justification of a plant should always be on the basis of a conservative recovery, principally because incremental increase in recovery is seldom lucrative. Further, a request for bids should include the base design recovery, oil rate, or other references to enable placing of bids on the same basis.

It is also desirable that the request for bids include sufficient data to enable the bidder to examine feasibility of an alternate scheme based on a different recovery. The bidder may then be enabled to submit an alternate proposal that could be more attractive.

Ethane Recovery

Recovery of ethane can not be expected to be economical unless a local market exists. Mounting demand for ethane by the petrochemical industry has, however, increased its value. Thus, if a considerable amount is available, possible markets should be examined.

Reforming of Natural Gasoline

Upgrading of natural gasoline by reforming is being done at a number of gasoline plants to facilitate marketing. Usually, installation of reformer facilities at gasoline plants is practical only where the products are sold direct to distributors. A central location is more economical due to larger capacity, lower operating cost, better maintenance, and greater flexibility.

Taxes and Outside Interests

Reliable economic studies can not be made unless such features as effective taxes and divided interests are known. There is often considerable difference between use of borrowed money and plow-back of profits as source of capital. It is wise to obtain company legal advice on, and interpretation of, tax laws and considerations, and contracts of sale, purchase or operation.

Processing Agreements

The producer will usually retain a reasonable return from liquids recovered by the gas purchaser. Most recent contracts allow the producer a return in the form of a percentage of gross products recovered. Fig. 9 shows that products left for distribution after all costs and taxes have been taken out varies considerably between situations and is especially dependent upon the volume of gas to be processed.

It is common practice for the processor to require the producer to pay royalty, fuel and shrinkage from his share of the products. Caution must be taken by the producer to avoid a situation where he covers much of the actual cost of the operation while realizing little or no return. As Fig. 9 shows, the producer is entitled to a reasonable share of the 29 percent of the products representing profit in operation of a 100 MM std cu ft per day plant processing 1.00 gal per Mcf gas over and above the fuel, shrinkage and royalty costs. On the other hand, the agreement should be flexible to encourage the purchaser to install a plant without excessive risk as would result with a small plant operated at only a little under capacity.

Management Attitude

The attitude which management is likely to have toward a project should be taken into consideration before a recommendation is made. If money is tight or company earnings are down, it is improbable that an investment will be made in a project which shows marginal earnings. On the other hand, if earnings are up, consideration will usually be given to a sound investment which does not show a high rate of return if payout of the original investment is not too long.

An economic study should be a cold financial analysis based on the best information available. It is no better than its basis. Management should assure itself that adequate information is available for such studies to be made. Management can encourage sound recommendations by taking personnel into its confidence in financial matters, requiring direct recommendations backed up by thorough analysis and clear conclusions, refusing to act on one of more persons' "quick decision," and clarifying why certain actions are taken in various instances.

Awarding Contracts Requires Caution

Many companies in the past had an engineering construction company make an economic survey and build the plant. For many reasons, practice now is for the processor to make his own study and let the contract by competitive bidding. However, blindly awarding a contract to the lowest bidder with the belief that the most economical results will be obtained may be the worst selection if the goods or service offered are not evaluated.

Generally the larger jobs are best handled by larger contractors. More specialized work might be best done by smaller organizations assuming they have adequate capacity and competent personnel. Thorough specifications are necessary for bids on the same basis, suitable equipment and elimination of incapable bidders. Specifications should be inclusive to avoid such over-expensive items as extra work.

Example of Comparative Economics

A large gasoline plant is to be installed to process lease gas. In another field 15 miles away, 20 MM std cu ft of gas is to be compressed for sale. The question to be resolved is the selection of a location for processing the remote gas. The recoverable liquid content of the gas is high and recovery of 50,000 gal per day of liquids has been determined to be economical. Sale of this gas is possible under a contract agreement at the main plant or sale can be made to a second purchaser at the local site at a price reduction of 0.5 cents per Mcf. The liquids would have an additional value of 0.1 cents per gal at the main plant. Local dehydration is necessary for sale or for transmission to the main plant, and local compression requirement will be the same. Royalty of the gas and liquids is 1/12, depletion allowance zero, capitalized depreciation on all investment 6 percent, income tax 50 percent, life 20 years, salvage zero, and discount value of money 10 percent.

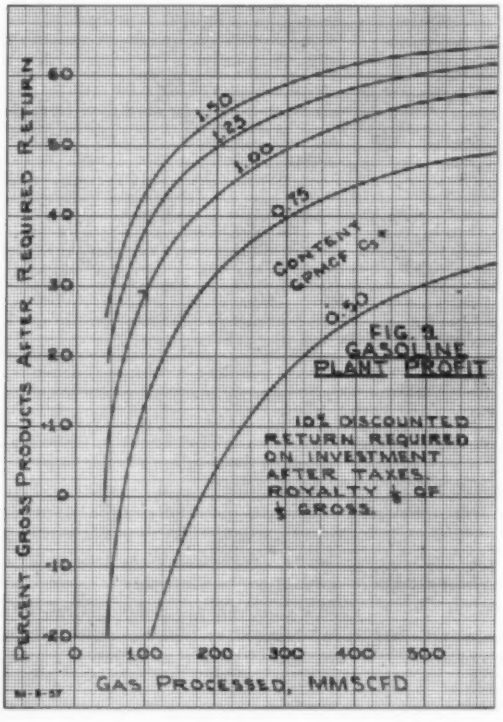
Case A: Process at main plant. Gas is to be dehydrated locally, free liquids filtered to remove water and returned to the gas stream, and the combined stream pipelined to the main plant for processing.

Case B: Process de-ethanized product at main plant. An abbreviated plant is to be installed locally, the de-ethanized liquid product transported to the main plant by pipeline for fractionation, and the gas sold locally.

Case C: Process locally. A small, complete plant is to be installed locally and all products sold here.

Comparative Economics for Various Processing Schemes.

SCHEME ITEM	Case A Process at main plant	Case B Process de-ethanized product at main plant	Case C Process locally
Comparable Initial Investment			
Pipeline	$500,000	$250,000	
Process facilities	350,000	630,000	$800,000
INVESTMENT	$860,000	$880,000	$800,000
Differential Yearly Gross Return (transportation gain)			
Gas sale	$ 36,000		
Liquids sale	18,000	$ 18,000	
GROSS RETURN	$ 54,000	$ 18,000	0
NET RETURN AFTER TAX AND ROYALTY	$ 26,550	$ 9,650	0
Differential Yearly Operating Cost			
Personnel	—	$ 14,000	$ 28,000
Maintenance	—	1,000	1,500
Power purchase	—	2,000	3,000
Insurance	—	600	—1,800
Overhead	—	2,000	3,000
OPERATING COST	0	$ 19,600	$ 33,700
OPERATING COST AFTER TAX ADVANTAGE	0	$ 9,800	$ 16,850
Present Value Comparison			
Investment	$—60,000	$—80,000	0
Return	+226,000	+82,000	0
Operation	0	—83,000	—143,000
NET PRESENT VALUE	$166,000	$—81,000	$—143,000
ADJUSTED NET PRESENT VALUE	$309,000	$ 62,000	0
If there had been no price advantage in transporting the products to the main plant, the net comparison would be:			
ADJUSTED NET PRESENT VALUE	$103,000	0	$ 20,000



It is quite evident from the table that pipeline to the main plant and reduction of remote facilities to a minimum is the most feasible plan. Other factors such as low salvage value of a pipeline in a short time project could significantly change the analysis. The study points out that the economics of operation should be considered before a contract is made for sale of products.

Caution should be taken to avoid what might appear to be a sound analysis but which gives distorted results. For example, that investment which shows the shortest payout will often be the worst selection simply because additional investment may increase the rate of return on the total investment.

The method presented allows investment, return and costs to be handled separately. This approach is particularly useful where a large number of situations are to be compared. The net result of one factor or change in one part can readily be shown and that phase of a particular plan which is unfavorable can be studied for improvement.

The calculation presented assumes that the company is operated at a profit; therefore incremental return after royalty is taxable after applicable depreciation has been considered. Operating cost will actually be paid before taxes and, therefore, in this analysis including cost and after tax return, would have a comparative value of actual cost times one minus the fraction of income tax (1-0.50 here). Should the company operation be on borrowed money (no net profit), care must be taken to consider the actual tax situation.

Editor's Note: Part 2 — Design of Cold Absorption Plants — of this series on Modern Gasoline Plants, will be in the June issue of *The Refining Engineer*.

GAS LIQUIDS LOOKING FOR MORE OUTLETS

Increased growth of petrochemicals, upgrading of products and better, cheaper transportation facilities are the keys

Although sales of liquefied petroleum gases and natural gas liquids are constantly achieving new highs, processors continue to look for even greater markets. Why?

According to a National Petroleum Council report (RE November 1957, C-30), recovery plants could produce as much as 12.2-billion gal of propane, butanes, and mixes. Actual 1956 production was about 8.5-billion gal, about 70 percent of total availability on a present-plant basis. This assumes, of course, that proration of gas and crude production would be lifted, thus corresponds to an emergency condition.

The report went on to point out that supply of LP-gases could be as much as 15.3-billion gal annually with plants expanded to handle the available gas supply.

While based on hypothetical conditions, these figures are nevertheless indicative of the increased sales that LP-gases could enjoy without major plant increases — given the markets and economical transportation to the markets.

Transportation Bottleneck

The full market potential for LP-gases, particularly propane, has scarcely been tapped in regions remote from producing areas. As almost everyone knows, the reason is simple: Present transportation costs from producing areas to those regions are too high.

High rail tank car shipping costs aren't the only problem; gathering lots for shipment from remote areas also involves high costs that the consumer must ultimately absorb.

Pipeline or deep-sea transportation of LP-gases, principally to the Northeast United States, could create markedly increased outlets. These forms of transportation, costing 50 down to 25 percent and lower than rail shipments, would enable establishment of a more attractive price structure than now exists, at least from the consumer's point of view.

But, pipelining and tanker or barge transportation present their problems. It's known that Texas Eastern's "Little Inch," converted to carry liquids, including propane, from East Texas to Moundsville, West Virginia, isn't setting the world on fire. Just one of the problems is accumulating 30,000 bbl or better tenders of LP-gas that would be required, not to mention the cost of storage facilities required at either end of the line.

The problem of shipping and receiving storage also plagues those interested in moving LP-gas by tankers or barges equipped with pressure bottles. Salt layer or dome storage can be used for shipping from the Gulf Coast, however, loading time would be quite high. On the receiving end (East Coast ports), cost of surface storage and receiving tanks couldn't be expected to be much less than $45 per bbl of capacity, even in large-capacity installations. Only other answer for receiving 100,000 to 300,000-bbl shipments would be caverns, mined from hard rock. These, too, are costly — from $7.50 to $15 per bbl, depending on size.

Bright spots. A Tulsa contracting firm is looking into the possibility of a line designed to carry propane from Texas into mid-New York State. Whether or not this project will work out is, however, problematical. Reports have it that the economics don't look too good, at the moment. But, this picture could very easily change.

Many suppliers of LP-gas to the East Coast and some of the large distributors in that area are looking at sea transportation as a means of reducing transportation costs. Guess is that it won't be much more than a year before someone has either a tanker or large-capacity seagoing barge hauling propane from the Gulf Coast to the East Coast. *The Refining Engineer* knows of at least three companies that are developing transportation techniques; none are ready to make a public disclosure of their plans, though. And, at least three firms in the supply and/or distribution business on the East Coast are building or considering construction of underground mined storage facilities. Further, there are already two storage cavities on the East Coast. One, of undisclosed capacity, is at Sun Oil Company's Marcus Hook, Pennsylvania, refinery, just south of Philadelphia. Another, consisting of two compartments rated at 300,000 bbl each, is nearing completion at Esso Standard's Bayway, New Jersey, refinery.

While it is believed that these cavities were mined primarily for interseasonal storage of refinery-produced propane and butanes, they could very easily serve as receiving capacity for tanker or barge shipments from elsewhere.

Growth in Petrochemicals Bodes Well

Southwest Research Institute has estimated that LP-gas sales at 9.8-billion gal for 1965, with about 30 percent of this — nearly 3-billion gal — used as raw material for petrochemicals (RE, January 1958, C-11). A. P. Hobbs, with the Dow Chemical Company, at the 1958 NGAA annual meeting in Dallas last month, showed data which checks with the SRI figure of about 3-billion gal. This projected consumption for chemicals manufacture is almost double the current level of about 1.67 billion gal annually.

More Hope for Natural Gasoline?

Many thought — ourselves included — that application of catalytic reforming and isomerization would be the panacea. And, it apparently is, but not where most everyone thought. There are only six gasoline or gasoline liquids processing plants equipped with catalytic reformers in the country; there are no more presently programmed for construction, to the best of our knowledge.

But, huge volumes of natural gasoline are being processed in catalytic reformers in refineries and processing centers. Examples are found at Atlas Processing Company's Shreveport, Louisiana, plant (which also has an isomerization unit under construction), Phillips Petroleum Company at Sweeny and Borger, Texas, in conjunction with crude oil refining operations, and Cosden Petroleum Corporation.

Obviously, the problem facing the natural gasoline producer is one of getting enough natural gasoline in one spot to justify catalytic processing. And, since so much natural gasoline is currently processed in refineries, he can not necessarily plan on increased sales of natural gasoline simply by upgrading it — unless he can do it cheaper than a large refinery and pass along the savings to the customer.

A fine and as-yet-unexplored outlet for natural gasoline would be for fueling automotive gas turbines . . . if Detroit ever gets into mass production on them. S.W.D.

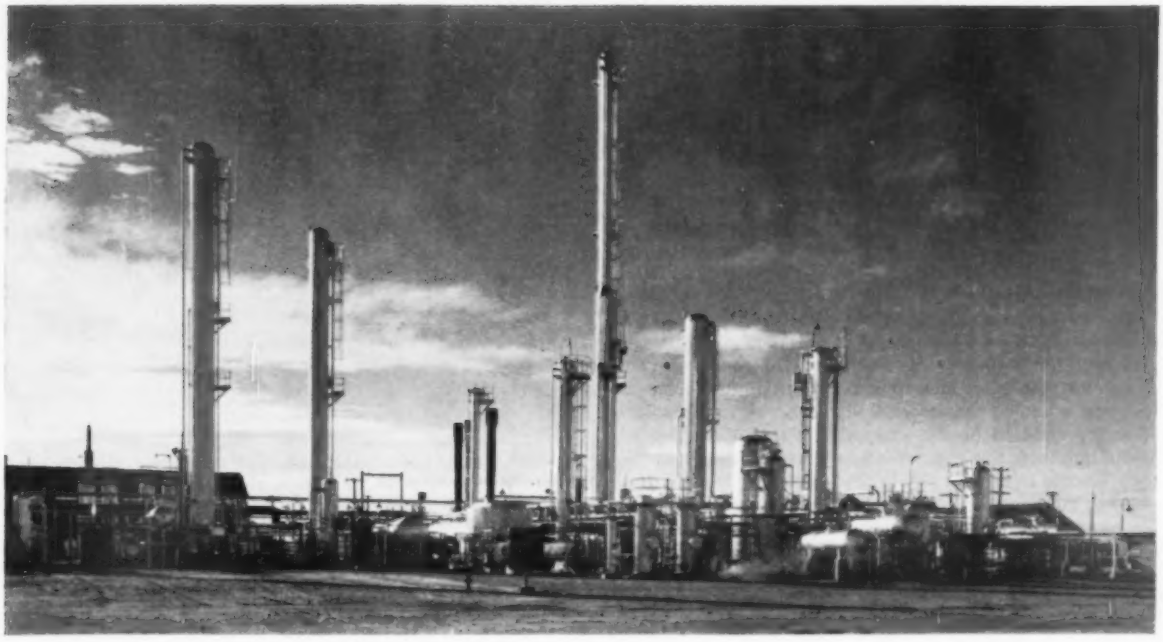


FIG. 1. Towers glisten at Atlantic's new Block 31 gas liquids recovery plant. — *Courtesy Delta Engineering Co.*

MODERN GASOLINE PLANTS

Atlantic Puts Automation to Work

. . . by using central startup and control plus automatic facilities for product transfer and underground storage at the Block 31 plant

B. L. Odom,
Atlantic Refining Company, Dallas, Texas

A LITTLE MORE than just instrumentation — a little less than complete automation. That's the way we describe the central control and startup arrangement at the Block 31 plant in Crane County, Texas, which is operated by The Atlantic Refining Company. We believe that this is a significant step which brings the natural gasoline industry closer to the goal of having instruments, instead of people, do the legwork — including startup and shutdown — in gasoline plant operation.

Growth of Block 31 Plant

The Block 31 plant was originally constructed in 1949 as a compressor plant to provide high-pressure injection gas for the Block 31 field pressure maintenance program. A stabilizing unit for compression condensate was a part of the plant. Coinciding with increases in field production and decisions to go from partial to full pressure maintenance, the compressor plant was expanded in a number of steps. By 1955 the compressor plant was handling enough rich field gas to make the addition of an absorption plant attractive. This expansion was completed in December 1957, making the Block 31 plant a full scale gasoline plant recovering about 115,000 gal per day of propane, butane, and natural gasoline.

Process Flow

As you see from the flow diagram (Fig. 2), the integrated plant is not very different from the usual absorption type plant which incorporates pressure maintenance. Field gas enters the compression section, is compressed to 1200 psi, and is stripped of propane and heavier liquids in the high-pressure absorber. The gas is further compressed to field injection pressure — 4000 psi. To supplement the field gas, extra gas of pipeline quality is purchased and compressed for injection. A breakdown of compressor horsepower by functions is:

Purchase Gas	Low-Pressure Field Gas	High-Pressure Field Gas
2640 hp	3360 hp	3440 hp

Liquids from compression are collected in the interstage separators and are added to the rich oil leaving the absorber. Pressure on the rich oil is reduced to 685 psi and gas from this flash is processed in the reabsorber. Methane and ethane are removed in the rich oil deethanizer; the natural gasoline and lighter fractions are then separated from the oil by steam stripping in the still.

Conventional fractionation breaks down the raw feed stock to make the final plant products — propane, butane, and natural gasoline. Since the gas is not sweetened before absorption, it is necessary to treat the propane and the feed to the debutanizer by caustic wash.

MODERN GASOLINE PLANTS

There are two progressive steps taken at Block 31 that reduced both investment and operating costs. These are in (1) central control and startup facilities and (2) automatic facilities in product transfer and underground storage.

CENTRAL CONTROL OF STARTUP

Central control and startup facilities are made up of instruments and controls which are commonly used in most plants. But we believe that the way we have put them together and fitted them into our operating plan is something new.

Operating Manpower

The pressure maintenance plant — before the absorption plant was added — was operated by two men per shift. One man operated the gas compressors and the condensate stabilizer unit; the other man took care of oiling the compressors and operated the steam boilers and air compressors. With the addition of the absorption plant, it became apparent that these two men would have as much work as they could handle in normal day-to-day operation. During times of other than normal operation — particularly during shutdowns and startups—we felt that there would be more work than two men could do. This presented a real problem because, at this plant, the frequency of unscheduled shutdowns is higher than that of most plants.

Power Interruption Causes Problems

At Block 31, electric power is furnished by a utility company. Interruption of the power is not uncommon. Even though the time when the power is off rarely exceeds a few minutes, the effect on operation of the absorption plant is nonetheless drastic. All pumps in the absorption plant are driven electrically so that the plant shuts down when the

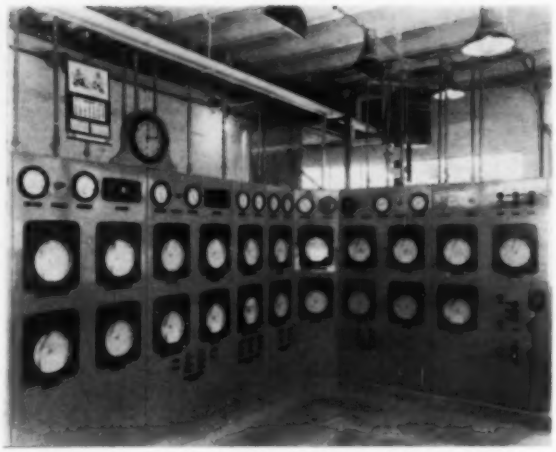


FIG. 3. Central control panel at the plant is U-shaped. Note the pump start/stop switches on the portion of the panel shown here. Panel on the extreme right contains the supervisory equipment for underground storage facilities 22 miles away.

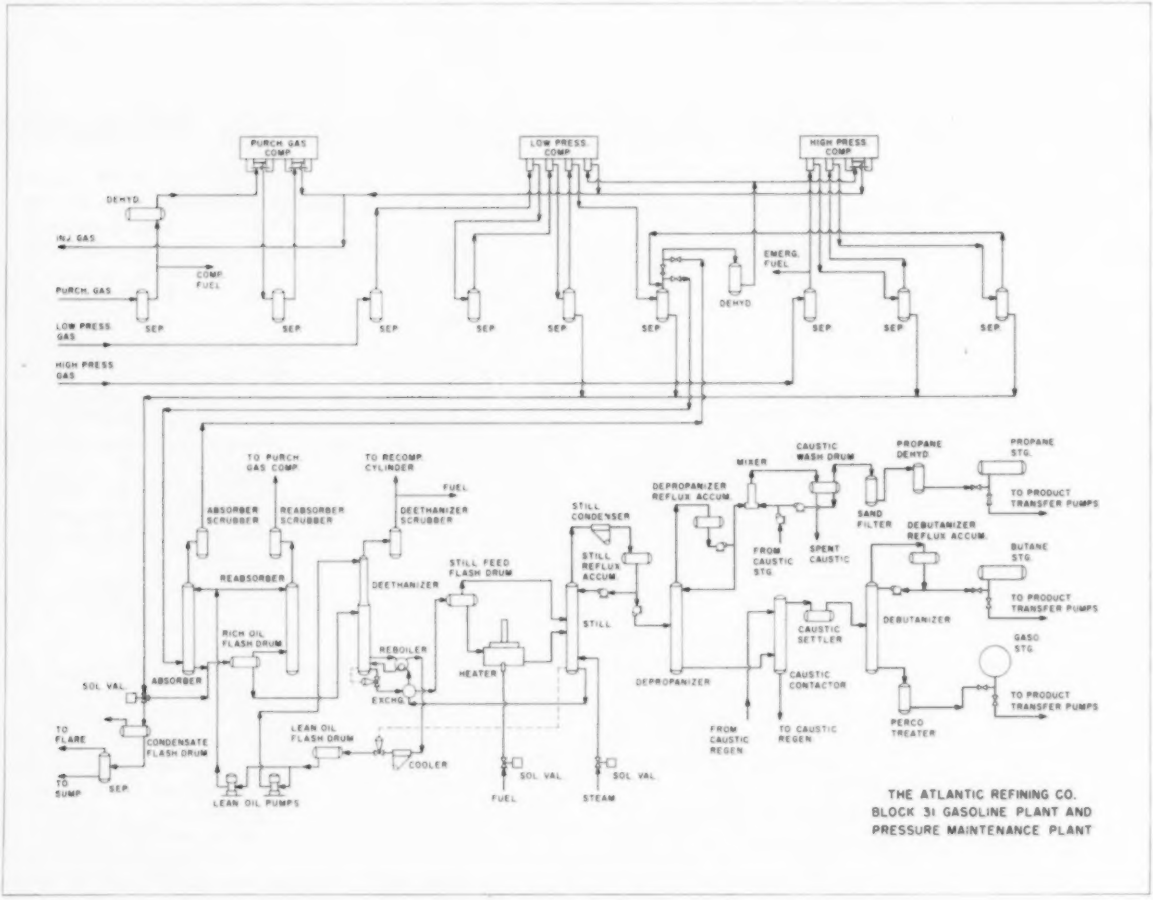


FIG. 2. Process flow in the Block 31 plant.

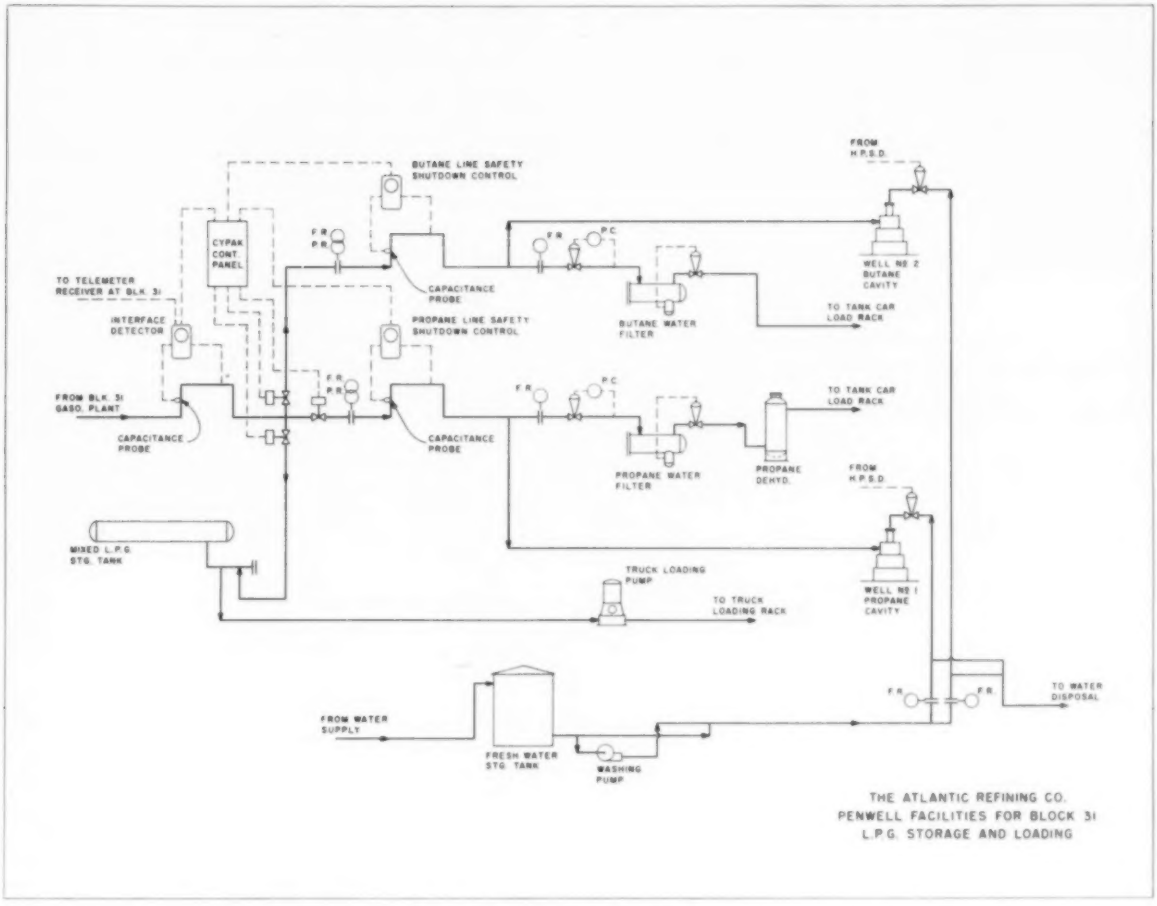


FIG. 4. Flow and control for LPG storage and loading facilities. Located 22 miles from the Block 31 plant, the operation is controlled by the Block 31 operator.

power goes off. As described in another paper[1] the pressure maintenance plant continues to operate through the use of devices which automatically switch critical equipment over to steam drive.

The problem of taking the frequent plant upsets in stride and achieving a desirable degree of operating efficiency was resolved by the decision to provide extra equipment to take most of the legwork of startup and shutdown off the plant operator. It was decided to provide a central control panel where all critical process variables could be observed and controlled and from which all critical pumps and other equipment could be started and stopped by one operator.

Design Bases

To arrive at a design, we started with the premise — based on past experience — that virtually all power interruptions would be of less than five minutes' duration. In this length of time, most operating pressures and many operating temperatures would not be far from normal, but operating levels in vessels would require attention.

A second premise was that in the absorption plant there are two types of systems to be reckoned with during plant startup. One type is, to a large degree, independent of the operation of other plant processes and does not require close operator attention to bring it up to operating conditions. The other type consists of processes which are dependent upon other unit operations and which cannot operate properly until a balance of temperatures, pressures, and flows exists throughout the system.

Examples of the "independent" systems are cooling tower system, propane caustic wash system, and butane caustic wash system. These can be left unattended, after a short duration shutdown, as soon as flow is re-established. Some of the "dependent" systems are the absorption-distillation system and the fractionation system. These require close attention on startup.

The third premise was that the plant would be attended by the same two operators. One operator would attend the compressor plant; the other would attend the absorption plant.

Working on the above-described premises, we were able to work out an operating plant and select instruments and controls which would automatically handle the plant on a power failure shutdown and which would enable a plant startup by one operator. These instruments and controls consist mostly of solenoid actuators with remote resets on key motor valves, remote liquid level indicators, and remote start-stop switches for motors on pumps and fans.

[1]Hartman, Russell C., "Pressure Maintenance in Block 31 Field," *World Oil*, Vol. 133, No. 4, September 1951.

MODERN GASOLINE PLANTS

B. L. Odom *graduated from Oklahoma State University in 1950 with a BS degree in chemical engineering. At that time he was employed by The Pure Oil Company's gas department as a roustabout. He was later promoted to plant engineer. He joined Atlantic's Natural Gas Section in Dallas in 1954 as operations engineer. In 1956 he was appointed operations engineering supervisor, the position he now holds. Odom served in the Air Force in World War II and the Korean War. He is a registered professional engineer.*

Shutdown Procedure

Here is what happens in the absorption plant when the electric power fails. Of course, all pumps and fans stop. Solenoid actuators operate valves as follows:

1. The three-way valve in the compressor condensate line diverts condensate to flare.
2. Fuel to the rich oil heater is shut off. Pilot gas is not interrupted.
3. Steam to the still is shut off. This is on delayed action in order to provide stripping for the rundown oil.
4. The deethanizer level control valve and the still level control valve close. This is to prevent all of the absorption oil from flowing into the lean oil surge tank.

Fuel gas for the compressor plant and boilers is supplied from the purchase gas inlet stream. Instrument air is provided by gas engine-driven compressors. Cooling water is supplied by stand-by turbine-driven pumps which automatically start when electric power fails.

Startup Procedure

When the electric power is again available, the operator first starts the "independent" systems. He starts the cooling tower pumps and fans. Then he starts the butane caustic pump and the propane caustic pump. After starting these flows, he goes to the control building and puts the rest of the plant into operation *without leaving the building.*

For startup of the "dependent" systems from the control building, the control panel contains the following:

1. Recorders and controllers on all important temperatures, pressures and flows.
2. Push-button starter with indicating lights on all pumps in the "dependent" plant and also on the still overhead fan cooler.
3. Liquid level indicators for all process tanks and vessels.
4. Remote reset controls for solenoid actuators. The solenoid actuator on the fuel to the rich oil heater must be reset manually at the heater. This was planned in the interest of safety in relighting the heater. The second operator, who works in the vicinity of the heater, checks the firebox and, upon signal from the first operator, manually resets the solenoid actuator on the fuel valve.

Justification for the System

It is not difficult for one who is experienced in putting a plant like this into operation to see how much time and work is saved with this design. A startup of this absorption plant, after the average power failure shutdown, can be completed in about one hour. This includes the time required to get the plant lined out on normal conditions. In this startup, the operator must walk through the plant only one time. These facilities more than pay for themselves each year through savings in operating expense and plant downtime.

PRODUCT TRANSFER AND UNDERGROUND STORAGE

It is about 22 miles from the Block 31 plant to the nearest railroad. A rail outlet for the propane and butane product was needed, so plans were made to move the two products to the railroad by pipeline. To reduce investment in product transfer and storage facilities, we used another design which is new in the natural gasoline industry.

In this design, only working storage was put in at the plant for propane and butane. These products are pumped in batches through a single pipeline to two underground storage wells at the railroad loading site.

Automatic Switching Equipment

To make the plan workable, automatic switching equipment was selected to put the product into proper storage. The flow diagram (Fig. 4) shows how this is done.

The product (assume propane) arriving at the storage-loading site from Block 31 passes a probe which measures its electrical capacitance. Working on this capacitance, the control unit opens the propane valve, allowing the product to flow to the propane storage well. When the next product (butane) arrives, the valve to the mixed LPG storage tank is opened by the control unit, and the interface mixture of propane and butane is put in this tank. The propane valve closes. After the line is cleared of the interface mixture and pure butane is sensed by the probe, the butane valve is opened and the mix valve is closed, directing the butane to the butane storage well.

Safety shutdown probes have been placed in the propane and butane lines. These probes will close all valves in the event the wrong product gets into these lines. When the valves are all closed, the product transfer pumps at the Block 31 plant are automatically shut down.

The entire switching operation is unattended. Information showing which product is arriving and the position of valves is telemetered to the Block 31 plant control panel. The Block 31 plant operator is in control of the operation.

Use of this automatic switching equipment eliminated the need for a second pipeline. Cost of this equipment was about 10 percent of the cost of the pipeline.

Conclusion

We believe that the schemes employed at Block 31 are just a preview of the automation which the industry will one day apply to gasoline plant operations. With the developments now available, only economics set the limits on gasoline plant automation.

Acknowledgment

The author gratefully acknowledges the assistance given by his associates in The Atlantic Refining Company. Special thanks are extended to the engineering staff of Delta Engineering Corporation who helped in the selection of the equipment for this project. The Block 31 Gasoline Plant was constructed by Delta from a design by Atlantic. Our thanks also go to Jack F. Laws, commercial photographer, Houston, Texas, who made the photographs used in this paper.

★ ★ ★

Sunray Mid-Continent's Snyder gasoline plant uses a process chromatograph for . . .

Better Absorber Control, Higher Recovery and More Profits

Bruce Denny
West Texas-New Mexico District Superintendent
Sunray Mid-Continent Oil Company
Snyder, Texas

A PROCESS MODEL chromatograph recently installed in Sunray Mid-Continent Oil Company's Snyder, Texas, gas line plant has resulted in savings beyond all original expectations. Increase in propane recovery alone resulted in a gain of $10,500 in December, compared to the October operations. And, improved operating conditions have resulted in a more smoothly running plant; employees have become rather enthusiastic and boastful about the installation.

Four product streams are sampled. In the original installation, residue gas from the two deethanizing absorbers was supplied to the analyzer. These two streams are connected to a three-way solenoid valve and are switched manually into the sample inlet line. From this point, the operation is fully automatic and the stream analyses are made every 15 minutes.

The hook-up was later modified to also include any of the four plant liquid product streams, as shown in Fig. 2. These streams are introduced into the analyzer through a sample vaporizer and programmed for continuous analysis.

Analyzer aids process operations. Aid of the chromatograph to process operations was immediately evident. Change in any operating variable on the absorber, such as oil rate or reboiler temperature, would reflect itself in residue gas composition in the next 15-minute sample. This frequent sampling enables the operator to see what is actually happening in the fractionator and make immediate compensation if needed. The process operator, knowing that absorber overhead is the only stream in which products are lost, has become very "recovery conscious" and relies quite heavily on the overhead analysis to a control guide.

Need for revising operating techniques revealed. Continuous analysis of residue gas made evident the need to revise two operating techniques in use at the time of installation. First, lean oil rates were controlled manually by sight reading inlet gas volumes; the oil-to-gas ratio therefore varies considerably and the propane recovery performed likewise. A series of tests was

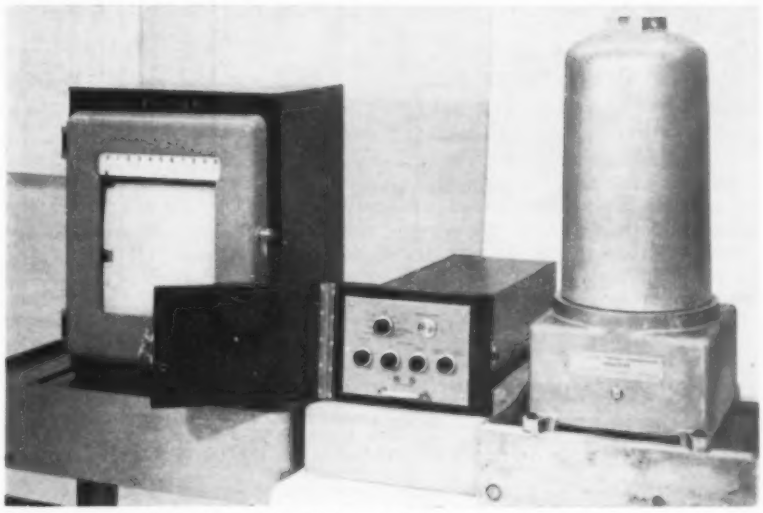


FIG. 1. A process chromatograph like this is used at the Snyder gasoline plant.
— Courtesy Consolidated Electrodynamics Corporation

set up to determine oil-to-gas ratio for maximum recovery. Having determined this, ratio controllers were put into service, with the result that recovery is now constant.

Second, operating experience had shown that there was a tendency to flood the absorber tower when the lean oil temperature was much below 80 F. This condition was brought about by excess lean oil rates and excess reboiler temperature that were required to make specification propane. Now, with oil rate on ratio control the oil and gas coolers operate at capacity and temperatures as low as 56 F have been recorded. Propane content of the inlet gas is about 5.25 gal per min and some residue analyses have been recorded at 0.05 gal per min.

Still another absorber operating problem had been occurring during the end-of-the-month slump in gas supply when inlet gas volume decreased rapidly. We knew for sometime that when this volume fell below 38,000 Mcf per day that the propane vapor pressure would tend to rise out of control range. Compensation for this was made by usually elevating temperatures to such a point that losses were excessive. The exact point at which this disturbance started was indicated by the analyzer, which showed a decrease in the ethane content of the residue. It then became recognizable what was happening in the absorber; an ethane build-up would start to form — not knowing when to make an operating change, propane vapor pressure would get out of control. With the aid of the continuous analyzer operating changes can now be made at the moment they are needed.

Product streams can be analyzed. Any one of the four product streams can be continuously analyzed. The column presently in the analyzer is not, however, suited for natural gasoline. But, one can be installed for this purpose.

The propane, iso-butane and butane streams have been run. Continuous analysis of the propane has enabled the operators to trim the depropanizer operation to such a point that a minimum of higher-value iso-butane is lost in the propane. Further, the butane splitter operation has been checked to verify conditions for iso-butane purity.

The chromatograph can also be adapted for manual sample entry and manual control for analyzing extraneous samples such as gas well gases, products from other plants and gas and liquid streams in other parts of the

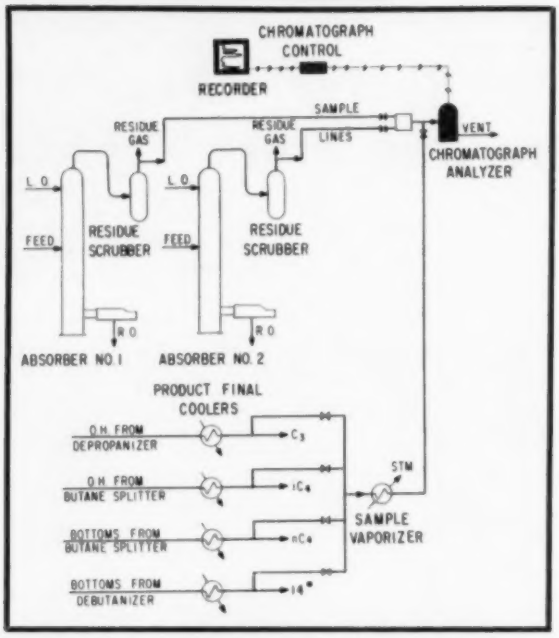


FIG. 2. Diagram of sample connections for the process chromatograph.

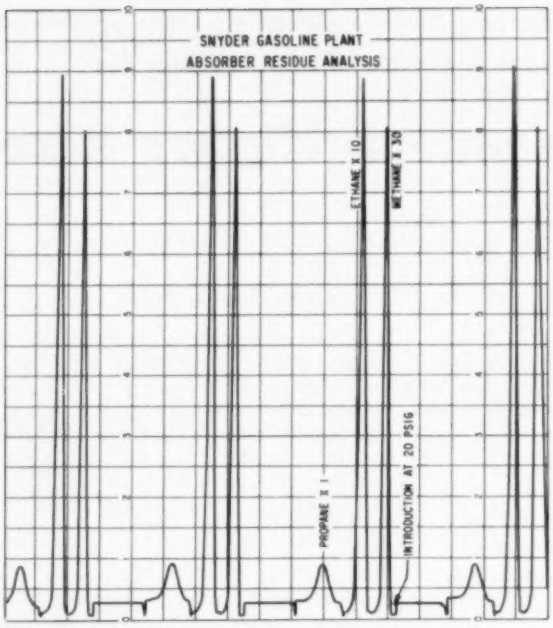


FIG. 3. Snyder gasoline plant absorber residue analysis.

TABLE 1. Economics of Propane Recovery Since Chromatograph Installation — November 1, 1957.

Using an Average Daily Gas Load of 41,000 Mcf/Day
Using an Average Daily Production of 404,000 gal/Day
3¢/gal of Propane
10¢/Mcf of Heater Fuel

Take the propane recovery in gallons per thousand and the amount of heater fuel used in cubic feet per total gallons of product. The totals for the month of October are used as the base figures.

	—Propane recovered—		—Heater fuel used—			
Month	C_3 recovery GPM	Diff from prev mo GPM	Heat fuel ft³/gal	Diff from prev mo ft³/gal	Dollars gained since prev mo	Dollars gained since October
October (31)	5.024		7.764			
November (30)	5.052	+.028	7.718	−.046	$1,100	$ 1,100
December (31)	5.303	+.251	7.866	+.148	9,400	10,500
				TOTAL		$11,600

This $11,600 is the gain in propane recovery (taking heater fuel into account) over October's operations.

The operation of the chromatograph costs $1.34/Day or $41/Month.

Snyder plant operation. The unit is considered, however, to be most valuable as a monitor for the two residue gas streams.

Operation and maintenance. There are no particular operating problems associated with the instrument — if the sample lines are designed properly for quick purge effects.

Good maintenance will come as the result of training the plant electrician to make necessary checks and repairs. Meanwhile, it is planned to use the manufacturer's service man for one year; thereafter, it is felt that the plant personnel can handle the required maintenance.

Operating cost for a 24-hour period is about $1.34, for helium and chart paper. Even this can be reduced by using the back side of the chart and a strict control of the helium rates.

Value of the instrument. Value of the chromatograph to the Snyder plant operation has been recognized by all concerned. As mentioned at the beginning, plant personnel have become surprisingly recovery conscious. The increase in propane recovery in the month of December, compared to October, resulted in a gain of $10,500 — more than twice the cost of the instrument. Increased earnings and improved operating conditions are the source of some enthusiasm and boasting by the Snyder plant employees.

ABOUT THE AUTHOR

Bruce Denny *has climbed rapidly in the Sunray-Mid-Continent Oil Company organization since his graduation from Texas Tech in 1949, with a BS in petroleum engineering. He started as a roustabout and pumper with Barnsdall Oil Company — now part of Sunray Mid-Continent — and a year later joined the Sunray gas division as an engineer and worked on initial construction and operation of the Snyder gasoline plant.*

In July 1953, he became district engineer for the Tri-State district of the gas division and in August 1955, was elevated to district superintendent of the Kansas-Oklahoma district. He assumed his present post a district superintendent of the West Texas-New Mexico district in February 1957.

First prepared for The Refining Engineer, this article was also presented to a forum on chromatography at the Natural Gasoline Association of America's annual meeting in Dallas, Texas, April 16, 1958.

Acknowledgment

Manning Davis, laboratory foreman, directed the installation and is responsible for its operation. Dana L. Smith, junior engineer, worked closely with the operating people and tabulated and reported the details of use and operation of the chromatograph. ★ ★ ★

Practical Design Considerations for Gas Purification Processes

Design tips and problems associated with the amine, iron sponge box and hot potassium carbonate processes

Fred Zapffe
Lone Star Gas Company
Dallas, Texas

THERE ARE a number of processes available for removal of hydrogen sulfide and carbon dioxide from natural gas. Most common are the amine, the iron sponge and recently, the hot potassium carbonate processes. Where does each excel? What are the comparative economics? What are the good and bad points of each? Here each is examined in turn and across-the-board.

The Amine Process

The amine-water — or if dehydration is desired, the amine-glycol—process has been the standard for many years for handling larger quantities of H_2S or acid gas. The amine plant can and will effect almost complete removal of H_2S. Consistent tests of amine-treated gas will show negative to basic lead acetate paper, which is accepted as a standard of H_2S purity.

Unfortunately, the amine removes all acid gases, i.e., carbon dioxide, along with the H_2S. In many instances, removal of even a small amount of H_2S means that large percentages of CO_2 must also be removed, just to sweeten the gas. This presents, of course, a disadvantage in the economics of plant installation, operation and gas shrinkage.

Minimizing corrosion. A well-designed amine plant will experience less corrosion than a poorly-designed plant. But, some degree of corrosion is a part of any amine plant. What constitutes good design is a big question. Factors to be considered include expected life of the project, and how it is desired to spend your money. In general, lower investment means higher maintenance and vice versa.

For example, corrosion can be related to solution loading. One curve showing the maximum amount of acid gas with which a mol of amine will react at a given temperature in a given solution strength shows that at a CO_2 partial pressure of 15 psia, a 2.0 normal (12.2 percent) solution of MEA at 22 F will react with 0.73 mols of the CO_2 per mol of amine. A plant built on this basis may operate for a while, but soon it begins to come apart at the seams and between the seams.

Design loading. It is generally agreed that 0.3 mols of acid gas per mol of amine is the maximum that should be attempted. Further, the smaller the amount of acid gas pickup that can be afforded, the longer the plant will run with a minimum of difficulty. And, don't attempt to approach the higher equilibrium figures closer than 65 percent of theoretical; viscosity of the foul amine solution becomes quite high at high loadings.

A plant can be designed for amine solution strength as high as 30 percent, but 12 percent is better, and 6 percent still better. Pumps and related equipment should be designed to circulate a low concentration amine solution for the immediately anticipated volume and acid gas content. Later, when the plant throughput and acid gas concentration may increase, increased load may be handled by increasing amine solution concentration to not more than 12 to 15 percent. The plant will last longer and operate more economically than by starting with 12 to 15 percent and then having to increase to a 20 to 25 percent solution.

Reducing amine costs. Amine is a costly item. There are plants today consuming as high as 20 lb of amine per Mcf of gas treated; this amine costs 25 cents per lb. Other plants operate at about 1 lb per Mcf. The difference is probably in design.

A good contractor is a must. It should have a sufficient number of trays for complete reaction, perhaps as many as triple the theoretical requirement. Extra trays are good insurance and also make good heat exchangers.

The contractor should be of generous diameter, too, with the mass velocity kept at a low value. In the Souders-Brown equation:

$$W = C\sqrt{d_2\,(d_1 - d_2)}$$

Where:

- W = mass velocity (max) of vapor, lb/hr/sq ft of tower cross-section area,
- C = constant, dependent upon tray spacing and surface tension
- d_1 = density of liquid, lb/cu ft
- d_2 = density of vapor, lb/cu ft at operating conditions,

use as low a value of "C" as can be afforded — never over 400 for a 24-in. tray spacing, lower if possible.

Have a good mist extractor system, too. One of the newest developments in this field is the wire mesh extractor. In general, for removal of very fine liquid particles, in the order of 10 microns, and less 0.006 in. diameter stainless steel wire woven in the form of a small mesh and packed in depths of 8 to 12 in. or more has given excellent results. Such steel mesh, interwoven with glass fiber strands, has given good retentive results on glycol. If a fine glass strand that will stand the alkalinity of the lean amine has or can be developed, an improved eliminator will result.

Reducing still losses of amine. Amine carried overhead in the still is another important point of loss. Constant operational supervision is required. If plant tests show that overhead condensate is running more than a few tenths of a percent amine, adjustments should be made.

In a properly designed still, the reflux rate can be increased to condense and wash more amine into the still bottoms. The reboiler must, of course, be able to handle the increased load.

If a chronic problem arises, the operator should be able to transfer still feed to a lower tray, thus increasing the number of trays in the rectifying section. The situation would also be improved if it were possible to reduce the amine solution concentration.

Still diameter is as critical as contactor diameter since excess vapor velocity could cause excess amine losses via entrainment.

Check leaks to reduce losses. The designer and the trouble-shooter often overlook plain everyday leaks as another point of amine loss. Flange gasket leaks in the high temperature sections of the regeneration area cause vapor losses that are hard to trace. Pump packing leaks, while only small, can add up if not properly handled. Atmospheric cooling sections in the cool-

Adapted from a paper given under same title at the Gas Conditioning Conference, University of Oklahoma, Norman, Oklahoma, March 5, 1958.

Fred Zapffe *has been designing plants for the Lone Star Gas Company since 1949. He is responsible for the design of gas purification and dehydration plants and compressor stations, as well as other problems such as corrosion, and gas interchangeability and purity. He also supervises the central laboratory and the cathodic protection activities of the company.*

He started with Lone Star in 1939 after receiving his BS in chemical engineering from Texas Technological College. He started in the gasoline department, working in several plants doing a variety of work including field research on gas dehydration problems before serving as Aircraft Engineering Officer in the Air Corps during the war. After the war, he was in direct charge of the company laboratory prior to moving into the design section of the engineering department. He is now design engineer for the company.

Zapffe is a registered professional engineer in Texas in chemical, petroleum and natural gas engineering. He is a member of the Dallas Section of the AIChE, and vice chairman of the Fractional Analysis Committee of the NGAA.

ing tower can leak at the tubing joints — check the cooling tower water for amine content.

To summarize, an amine plant can be kept physically small to minimize investment. But, operational costs for maintenance and amine losses will be higher. The more oversized — within reason — the components of the amine plant can be made, the lower the operating and maintenance costs will be.

The Iron Sponge Box Process

The iron sponge method has not received the prominence that it deserves. It has the advantage of being a proved method for removing H_2S and other sulfur compounds without removing CO_2. Removal is essentially complete: The basic lead acetate will test negative at the outlet of the box.

On the other side of the ledger — of importance to gas transmission companies — it will remove mercaptans that may have been added to odorize the gas. Also, it is a batch process, requiring periodic change-out, entailing either parallel installations or shutdown periods.

Iron sponge described. Iron sponge is wood shavings, available in various sizes and textures of shavings or chips, impregnated with a special hydrated form of iron oxide. The shavings serve only to space out the iron oxide, to control gas distribution, and to control pressure drop. Several grades are available: 6.5, 9.0, 15.0, and 20.0 lb of active iron oxide per bushel of shavings. Properly packed in a vessel, a bushel (1¼ cu ft) should occupy 1 cu ft. Preliminary cost, for estimating purposes, is $2 per bushel, delivered in Texas or Oklahoma.

Design of iron sponge boxes. In his paper presented at the 1956 Gas Conditioning Conference, D. K. Taylor, of Connelly, Inc., set out a few rules for design. Here are those rules and a few comments on each:

1. Bed depth. The oxide bed should be at least 10 ft deep to give sufficient pressure drop for good distribution. Increased depth, unless supported on trays, gives excessive pressure drop due to compaction. Increased depth is, however, worthy of consideration as a means of increasing bed life and minimizing expense of changing the charge.

2. Vessel diameter. Diameter should be such that sulfur deposition is limited to a maximum of 15 grains per sq ft of cross-sectional area per minute. In design, it must be remembered that H_2S or sulfur content is usually expressed as grains per 100 standard cu ft. The rule given here must consider the number of grains of H_2S that will be present under actual operating conditions which might be several atmospheres of pressure and thus several times the concentration of the standard test results. This becomes especially critical when designing for high sulfur concentration or high operating pressures.

The upper limit should not be exceeded, and the lower it can be held the more complete the chemical reaction will be. Theoretical reaction is 0.56 lb of sulfur per lb of iron oxide.

3. Contact time. This can be easily figured by assuming empty sponge bed volume expressed in cubic feet, divided by gas throughput under actual operating conditions expressed in cubic feet per second, to find residence time expressed in seconds. In case of variable operating conditions, the minimum pressure should be used.

Taylor has indicated that residence time based on empty bed volume should be 15 to 20 seconds or 240 to 180 actual cu ft per hr per cu ft.

This rule needs careful evaluation. For example, Taylor qualified the 15 second rule by use of a few tenths of a percent of oxygen in the gas stream to reactivate the iron sulfide that is formed.

Economical utilization of oxygen or air injection into the gas stream is, however, subject to debate. If air is not present, we have found that a residence time should approach 60 seconds rather than 15 to 20 seconds for maximum utilization of the iron sponge. This can be an advantage, though. The larger vessel required minimizes the major expense in operation of the iron sponge unit, the change-out operation.

4. Bed life. Life of a charge of iron sponge bed must be considered if bed size as indicated by rules 2 and/or 3 above is so small as to call for frequent change-outs. Cost of the sponge is not a variable in this; a properly designed vessel will give a one-time removal of 0.56 lb sulfur per lb iron oxide. Under conditions of oxygen regeneration, a pound of iron oxide will possibly remove as high as 2½ lb of sulfur.

5. Selection of sponge. If regeneration is not to be used, the 15-lb sponge will give maximum utilization before the bed becomes sufficiently filled with sulfur to produce excessive pressure drop. If air regeneration is to be used, the 9-lb sponge possibly will give better purification performance. But, it might become blanked off with sulfur before the iron oxide is fully spent. Oil will also seal off the sponge.

6. Change-out operation. When oxygen contacts the bed, an exothermic reaction occurs. Thus, the bed should be wetted down prior to opening for servicing to prevent spontaneous combustion that could occur when the bed is exposed to the atmosphere. If water is unavailable, the sponge must be removed as rapidly as possible and with minimum exposure to air. In any event, several men should be present during change-out to speed the work and help in event of emergency.

Sponge can be difficult to remove. The sulfur will act as a mortar, holding the shavings together. It is usually brittle, however, and will crumble once broken loose. Vessel design can ease this removal problem. One method is to twine chain or cable in the vessel as it is being loaded and when unloaded, the chain or cable first pulled out to break up most of the material.

If the vessel is vertical, sponge can be removed from the bottom and fresh charge added from the top. One 800 psig vessel, 14 ft high by 3 ft diameter, was balanced by hand crank around a pivot so that the same opening could be used for emptying and filling.

Again, it's emphasized that the vessel diameter should be as large as economically possible to both decrease number of change-outs and also in-

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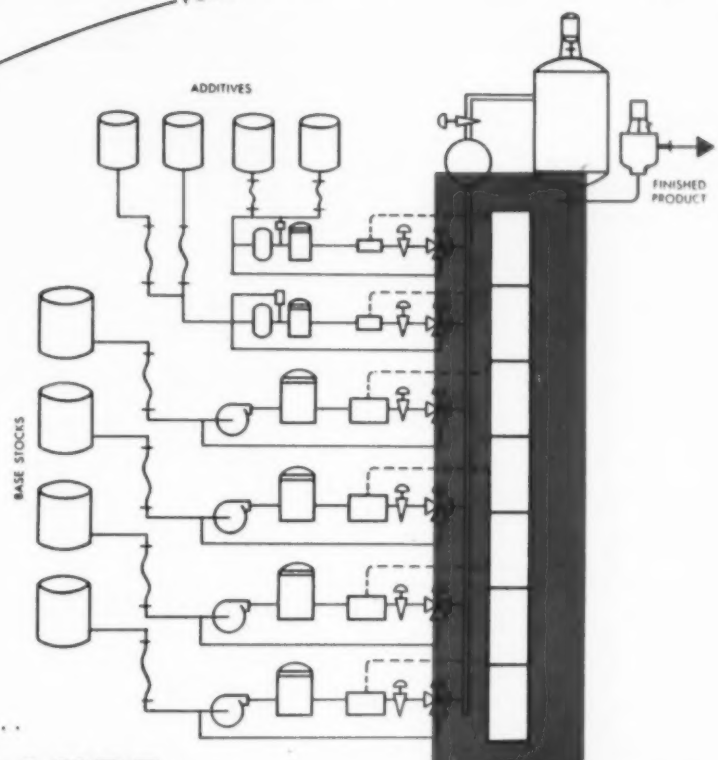

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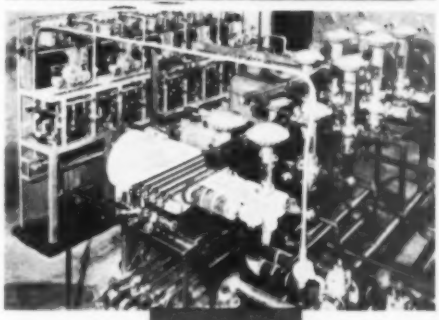

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crease residence time for most efficient conversion of iron oxide to iron sulfide.

Design for regeneration or not? My findings are that regeneration should not be used, although yours may differ. Basis for this conclusion is as follows:

With a new charge in place and a steady flow of sulfur into the vessel, sulfur may "break through" or give a positive sulfur test after, say, 60 days' operation. After regenerating with a portable or permanent air compressor, the bed is ready for a second run. (Don't let the bed get above 120-130 F or it might ignite.) This time, bed life may be only 30 to 40 days. After a second regeneration, bed life may be only 10 to 15 days.

We have found that 15-lb sponge, at longer residence time without regeneration, will operate more economically than 9-lb sponge with several regenerations. Further, the labor involved might come close to that required for change-out. The reduced bed life following regeneration, combined with cost of regeneration, thus makes the technique a questionable economic venture.

Our plants are, however, at the wellhead, a good distance from headquarters. If the purification plant is in the plant yard where air supply and labor is readily available, the story could be different.

To summarize the iron sponge process, it has the advantage of removing only sulfur compounds and requires only a small investment, compared to other processes. Even though it is a batch process calling for parallel vessels or periodic shutdown, it can be economical from the operating standpoint.

In spite of appearances, it is a good, safe, practical method — many such units have been used with no serious problems.

The Hot Potash Process

This process has been just recently introduced to the natural gas industry for removal of large quantities of acid gas. It is usually used in conjunction with an amine plant as follow-up, the amine removing traces left by the carbonate method.

Indications are that economics of a carbonate plant followed-up with an amine plant are better than those for a single amine plant with sufficient circulation to do the same job.

The process is not described here since the article immediately following gives full details.

Comparison of the Processes

Which of these three purification processes — the amine, iron sponge, and hot potash — are best used where? Each has certain areas practically reserved for that process alone. In overlapping areas, the only practical thing to do is to determine the economics for each of the two processes, making selection on that basis.

Starting with the low end—low pressures, small volumes of gas, and low sulfur concentration — iron sponge is best in terms of economy and purity of product. Iron sponge also is quite economical at high pressures; the economics swing from sponge box to amine only when sulfur loading becomes too high. It should be noted also that at some pressure below 100 psig, the amine process will not produce completely sweet gas.

At the upper end of the range, hot potash seems to take over. At values ranging from possibly 8 percent sulfur or acid gas and upward, this process should, by all means, be investigated.

In the middle ground of the acid gas concentration, gas volume and operating pressure complex, the amine plant is just about the only practical choice to make.

In overlapping areas, comparative economics depend on the developer's viewpoint, the background and future of the project, and other factors that only detailed engineering evaluation can decide. ★ ★ ★

Chromatographic Analyzer Used to Control Debutanizer

Phillips Petroleum Company has successfully used a standard commercial chromatographic analyzer, with a five minute cycle, to control a natural gas liquids debutanizer Phillip's engineer Melvin M. Fourroux* reported to the NGAA's annual meeting in Dallas, Texas, April 16.

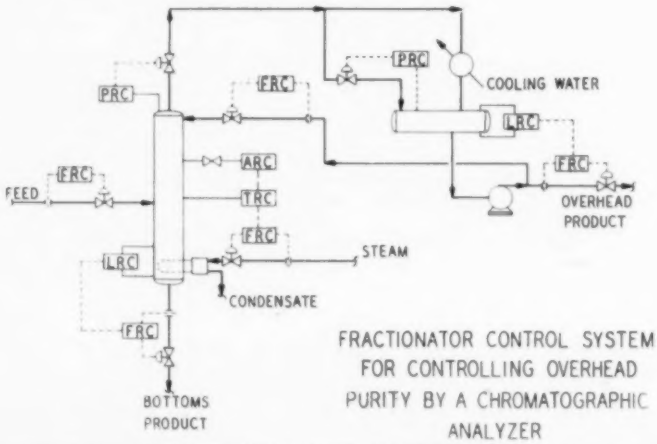
This was enabled, he said, by use of a Phillips-developed peak reader with continuous outlet. The analyzer, measuring isopentane vapor on ninth tray of a 50-tray column, controlled steam flow to the reboiler through a temperature recorder-controller on the 14th tray. Fourroux said that this cascaded control system provided stable, sensitive quality control. During a one-week test run, isopentane at the ninth tray was held within ±0.2 percent at a level of about 2.5 percent, except for a 0.6 percent deviation caused when steam to the preceding column, a depropanizer, was completely shut off due to an instrument failure. The largest deviation was right after the disturbance and completely stable performance was regained in 90 minutes without losing control or product quality.

The peak reader, Fourroux pointed out, was tied into the chromatograph's programmer and read the peak height of the key component, giving an equivalent output signal which was constant and suitable for control purposes.

Purpose of the successful test run was to see if an ARC could be used on the outside loop of a fractionator control system. Information was provided for design of a revised flow plan, with butane and propane removed in the first column (debutanizer), propane taken overhead in the next column, and butane bottoms from this second column split into iso and normal fractions in the final column.

As in the test run, Fourroux stated, isopentane (in the first column) will be monitored and controlled. In this case, though it will be near the top of the column at whatever level necessary to allow just a trace of isopentane in the overhead.

*Research and Development Department, Bartlesville, Oklahoma.



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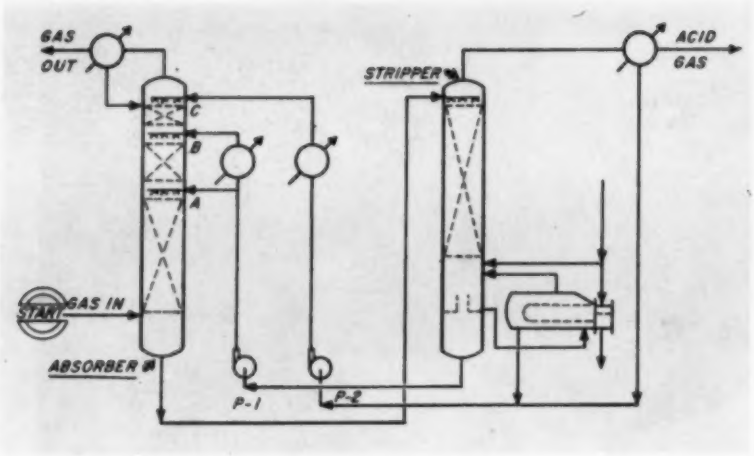


Various split-flow arrangements are possible with the hot carbonate process. Selection depends on acid gas concentration.

Investigate the

HOT POTASSIUM CARBONATE PROCESS

for acid gas removal

Robert A. Graff
Graff Engineering Corporation, Dallas, Texas

WHEN A NEW PROCESS offers substantial operating economies, gas processors become interested. This is much the case for the hot potassium carbonate process. It promises to become an extremely useful tool for processing high acid gas content natural gas.

Relative Economics

The major difference in the two available processes is the fact that the hot carbonate process operates at substantially the same temperatures in both the absorber and the stripper, and solution heat exchangers and coolers are not usually required. The reason for operating the hot carbonate system at elevated temperatures is because a more concentrated solution of potassium carbonate can be maintained. This is because the reaction product, potassium bicarbonate, does not separate from the solution at the operating temperature of 220 to 240 F. Almost complete conversion of carbonate to bicarbonate is obtained at moderately high carbon dioxide partial pressures.

The hot carbonate process can recover 6 to 8 cu ft of acid gas per pound of process steam utilized. Average recovery using the MEA process is 3 to 4 cu ft of acid gas per pound of process steam. Cooling requirements also are reduced approximately 50 percent where the hot carbonate process is used.

Losses of chemicals to the separated gas streams are nil because of the nonvolatile nature of the carbonate solution. Elimination of make-up chemicals means that an appreciable operating economy is obtained.

Process Limitations

The hot carbonate process is unfortunately limited to applications involving the removal of relatively high concentrations of carbon dioxide or hydrogen sulfide from gas mixtures. In general, it can be considered for use at acid gas partial pressures of 15 psi or above. Degree of purification ordinarily obtained by use of the hot carbonate process is not nearly as good as obtained by the MEA process, especially at low acid gas concentrations. It is not anticipated that the hot carbonate will displace the MEA process, except for large volume and high acid gas partial pressure applications.

Recovery

Based on a typical hot carbonate process application, unpurified synthesis gas will contain approximately 20 to 30 vol. percent carbon dioxide at a treating pressure of 200 to 400 psig. Treated gas will contain 0.5 to 2.0 percent carbon dioxide. Where complete acid gas removal is required, residual carbon dioxide can be removed using a conventional MEA type unit.

Both hydrogen sulfide and carbon dioxide are absorbed by hot potassium carbonate solution, and are regenerated at the same rate.

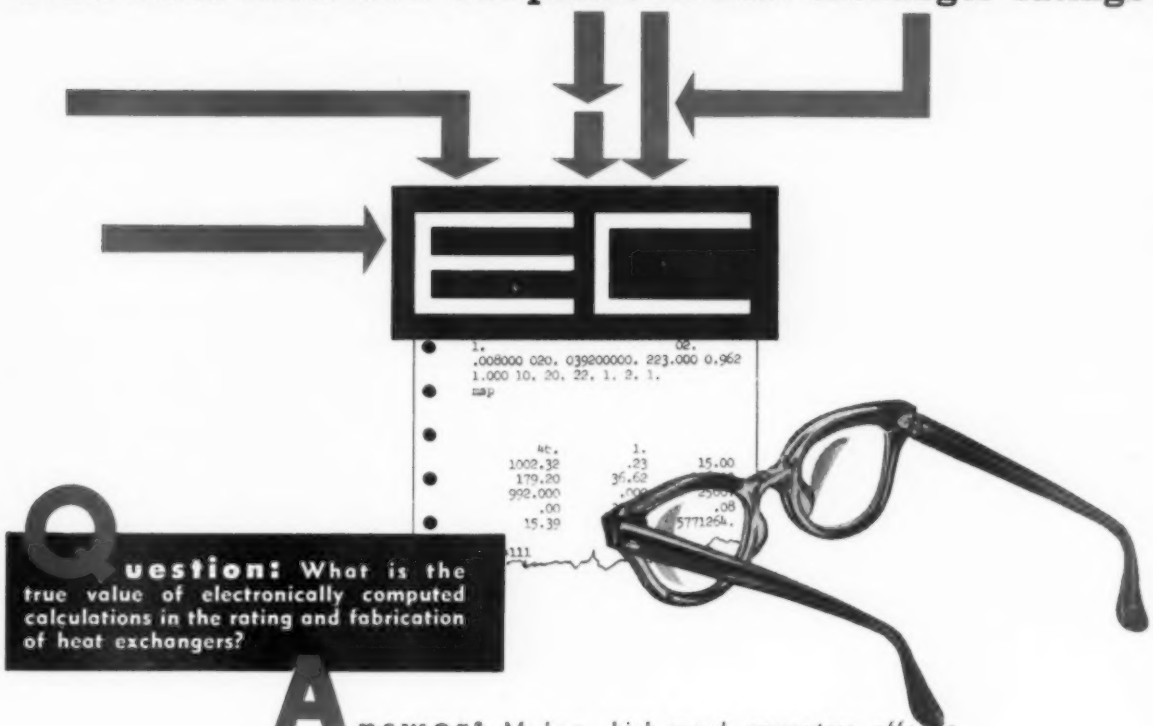
Process Description

The hot potassium carbonate process has been used in the past for the recovery of carbon dioxide from products of combustion gases,[1] and it has only been recently that complete equilibrium data has been made available, covering the design of hot carbonate units.[2]

Gas contactors used for the hot carbonate process are usually Raschig ring packed vessels designed to allow sufficient contact time for the chemical reaction to be carried out. Considerably more liquid-gas contact time is required, as compared to the MEA process.

Inasmuch as low pressures favor the more complete stripping of the hot carbonate solution, solution strippers are usually also Raschig ring packed vessels, since these vessels can be op-

What about Electronic Computers in heat exchanger ratings?



Question: What is the true value of electronically computed calculations in the rating and fabrication of heat exchangers?

Answer: Modern, high-speed computers offer a high degree of accuracy, and enable a fabricator to carry a high volume of design ratings, HOWEVER . . .

. . . AT WESTERN, we recognize that, accurate as our electronically computed data is, the *effectiveness* of Western heat exchanger ratings depends on the *interpretations* our rating engineers put on the data. Thus personal scrutiny, years of experience with our customers and intimate knowledge of customer preference — all work together to produce the equipment you require *for your specific need.*

In the utilization of electronically computed data, a prescribed course is followed and should be thoroughly understood by both fabricator and customer.

First, the thermal and mechanical information is given by the customer. Second, preliminary calculations are made to set up the average physical and chemical properties of the fluids involved.

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Fifth — and MOST IMPORTANT AT WESTERN — each resulting rating is carefully scrutinized by our engineers in view of their extensive experience in the heat exchanger industry, as well as their background in customer preference. For years, Western has recognized that the true value of our electronic computer depends not only on the accuracy of the original data, but upon the precise and pertinent interpretations of the ultimate ratings by Western engineers, in light of each customer's specific application.

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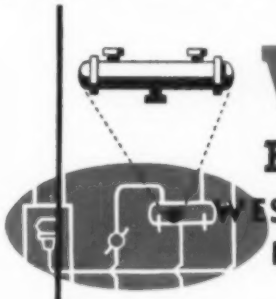

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erated at low tower bottom pressures.

Both closed and live stripping steam can be used for solution regeneration. Where conditions permit, the entire overhead from the solution stripper can be vented at the top of the vessel to the atmosphere.

Materials of construction for the hot carbonate process are mild carbon steel; however, in some cases, the absorber is protected by an internal gunited lining or plastic coating. Corrosion or erosion has been noted at points of high liquid turbulence, such as at the absorber solution outlet control valve and at the solution pumps. These items are usually constructed of type 316 stainless steel, with heat treated or hard faced wearing parts.

Multistage solution pumps, utilized for high-pressure hot carbonate solution pumping applications, usually require several feet of net positive suction head to overcome entry losses at the pump suction. Some flashing can occur at the suction of the pumps during normal operation, with partial cavitation, resulting in excess pump vibration and corrosion or erosion of the pump wearing parts.

The use of a separate slow-speed, single-stage solution charge pump requiring a low NPSH is recommended to transfer solution from the stripper to the suction of the high-pressure pump, and provides sufficient pressure to eliminate this condition. Copper bearing alloys are not suitable for hot carbonate service.

Solution filtration is often required to remove mill scale and solids disengaged from the equipment during operation, in order to prevent wear at the motor valves and pumps. In plants where carbon dioxide is the only acid gas constituent present, sodium dichromate has been used as a corrosion inhibitor; however, this inhibitor is not used when hydrogen sulfide is present.

Process flow. Under conditions that require a higher degree of acid gas removal, a two-stream split flow arrangement has been recommended[3] and a three-stream split flow arrangement would be even more effective. The 0.25 grains of H_2S per 100 std cu ft purity specification covered by most natural gas contracts would probably be difficult to consistently obtain without the use of some follow-up treatment of the gas.

Fig. 1 illustrates the various split-flow process modifications possible. The conventional non-split flow arrangement would be for all the solution to pass through P-1, and enter the absorber at "A." Under two-flow, split flow conditions, the major portion of the solution from P-1 would enter the absorber at "A", and a minor portion would be cooled to approximately 200 F and enter the absorber at "B."

A further modification involving three-stream split flow would be the same as previously described, except that more highly regenerated solution would be withdrawn from the reboiler and pumped by P-2 to point "C" at the absorber.

Dilution of the solution added at point "C" by condensate from the outlet gas cooler would also be desirable for three-stream split flow.

Investment

Cost of a hot carbonate system followed by an MEA system is in the same price range as for one single MEA system to handle the complete load.[4] From an operating cost standpoint, however, fuel and chemical savings would dictate the selection of the combination system.

Robert A. "Bob" Graff *has spent most of his professional life in the gas purification field. After several years' work with Girdler, in connection with the original laboratory and pilot plant development of the Girbotol Process, he established his own company in 1944, and has since been active in the specialized field of gas desulfurization and sulfur recovery. He is a graduate of the University of Florida, with post graduate work at Louisiana State University. Graff is a member of AIChE and ACS, and the author of several technical articles covering sulfur recovery practices.*

Several hot carbonate process plants have been placed in operation in recent months, in connection with the purification of synthesis gas; however, it has not been until recently that this process has been applied to natural gas processing.[5] A major gas producer is now installing a 100 MM std cu ft per day hot carbonate process plant in the South Texas area. This plant will be the largest installation of this type made to date.

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3. Benson, H. E., Field, J. H. and Haynes, W. P., *Chem. Eng. Progress*, 52, 433 (1956).
4. Mullowney, J. F., *O & G Jour.*, 56, No. 6, 93 (1958).
5. *O & G Jour.*, 56, No. 6, 98 (1958). ★ ★ ★

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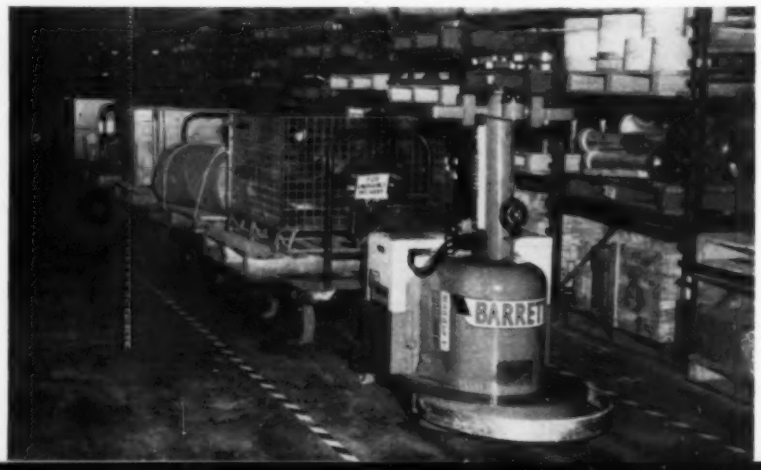

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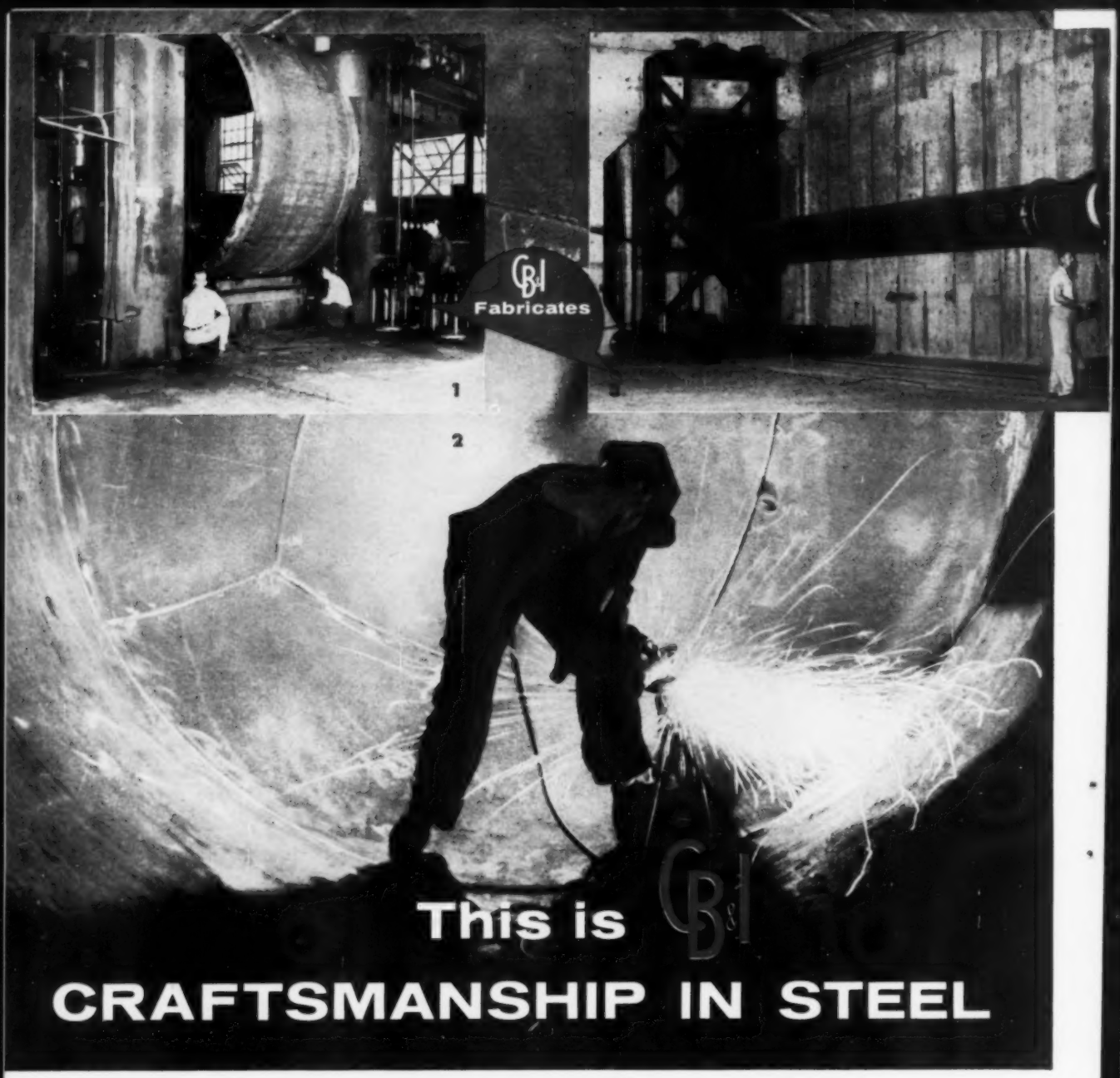

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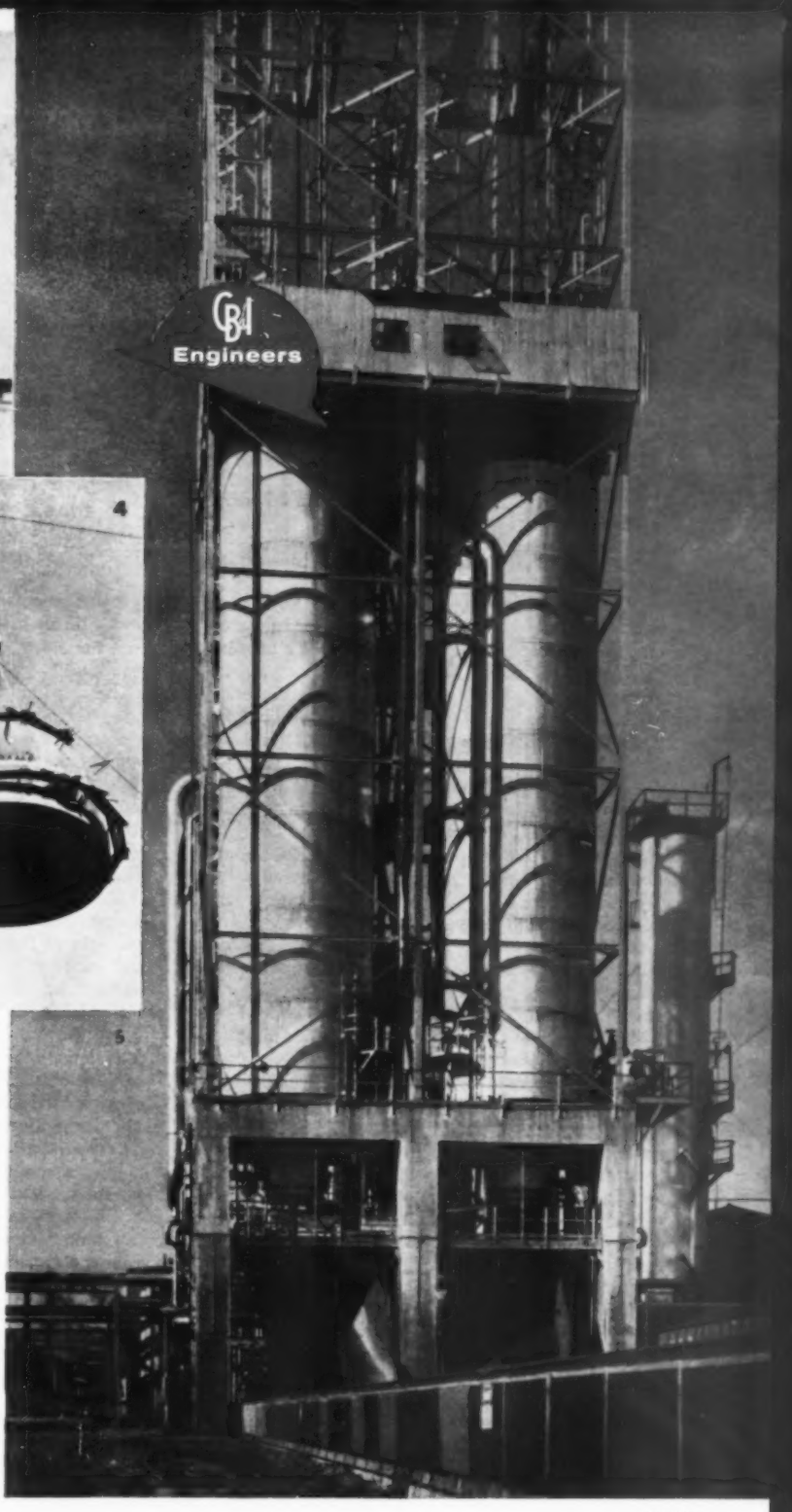

1 5-in. thick plate for reactor is fabricated at CB&I's Birmingham plant.

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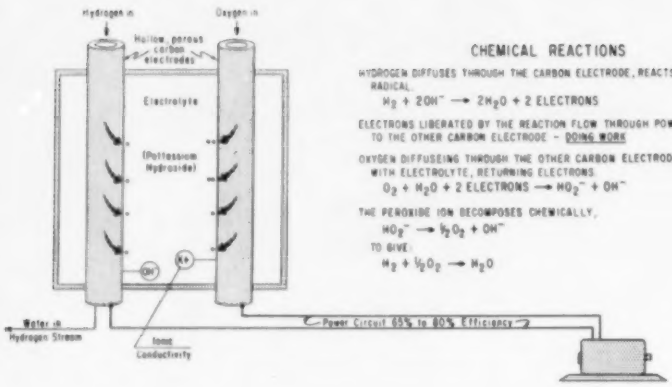
Electricity Directly From Gas?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CHEMICAL REACTIONS
HYDROGEN DIFFUSES THROUGH THE CARBON ELECTRODE, REACTS WITH OH⁻ RADICAL.
$H_2 + 2OH^- \longrightarrow 2H_2O + 2$ ELECTRONS
ELECTRONS LIBERATED BY THE REACTION FLOW THROUGH POWER CIRCUIT, TO THE OTHER CARBON ELECTRODE – DOING WORK
OXYGEN DIFFUSEING THROUGH THE OTHER CARBON ELECTRODE, REACTS WITH ELECTROLYTE, RETURNING ELECTRONS.
$O_2 + H_2O + 2$ ELECTRONS $\longrightarrow HO_2^- + OH^-$
THE PEROXIDE ION DECOMPOSES CHEMICALLY,
$HO_2^- \longrightarrow \frac{1}{2}O_2 + OH^-$
TO GIVE:
$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

Fuel cell has efficiency of 65 to 80 percent, using hydrogen and oxygen! Research laboratories are excited over possibilities

THE CONCEPT of a fuel cell that could be used to convert the cheap chemical energy of gases into electricity has been a scientific dream for over a century. Now National Carbon Company has announced development of such a cell which is capable of producing thousands of watts of power economically by ionization of hydrogen and oxygen in a plastic, compact unit.

While not the first fuel cell, the National Carbon version is the first one that doesn't depend on high pressures and temperatures for operation. Designed to work at ambient temperatures (120 to 140 F) and approximately atmospheric pressures, the new fuel cell eliminates the need for costly and bulky auxiliary equipment and heavy pressure vessels. Devoid of moving parts and containing no exhaustible components, the cell's electrolyte is not depleted by normal operation and requires little or no maintenance. Contrast this with the primary battery (such as in the flashlight) which produces electrical energy by the consumption of its own chemical elements until dead, or the secondary (auto) battery which can be recharged only by passing electricity back into it, and you glimpse the revolutionary nature of the fuel cell.

While no fuel cell is 100 percent efficient — some of the energy produced is wasted as heat — another advantage of the new cell can be seen when it is compared to a conventional steam system in which the heat is supplied by burning gases. Failure to utilize all of the heat produced reduces the overall efficiency of a steam system to approximately 30 to 35 percent, while **the fuel cell, which eliminates the intermediate heat step and converts directly from chemical to electrical energy, has a top efficiency of about twice that figure, utilizing, at normal temperatures, 65 to 80 percent of the energy available in the hydrogen-oxygen fuel.**

What is it? The fuel cell is merely a sealed jar into which are fed hydrogen and oxygen through special hollow electrodes. Electrochemical reaction of the gases at these electrodes produces an electrical current with water as the sole by-product. The life of the fuel cell is theoretically unlimited.

Actually the operating principle is simply water electrolysis in reverse. Electrical energy is produced by oxidation of hydrogen to water, and a current flow is established that can be routed through an external circuit.

How it works: Secret of the new fuel cell's success is the chemically treated, hollow, porous carbon electrodes through which the gases enter and which conduct the electricity produced by the electro-chemical reaction.

In operation, hydrogen diffusing through the negative electrode is ionized by electrochemical reaction with the electrolyte solution of potassium hydroxide and liberates electrons which flow through an external circuit and back to the positive electrode where the electrons are accepted by the ionizing oxygen. Ionic conductivity through the electrolyte completes the electrical circuit; water produced by the reaction is disposed of by evaporation. Voltage across the cell is about one volt. Current capacity is determined by the physical size of the unit. By varying the number and size of the cells many combinations of voltages and currents can be obtained (the army's "Silent Sentry," for example, is powered by cells connected in series to produce 28 volts). Basically, however, the fuel cell is best suited to high-current, low voltage applications.

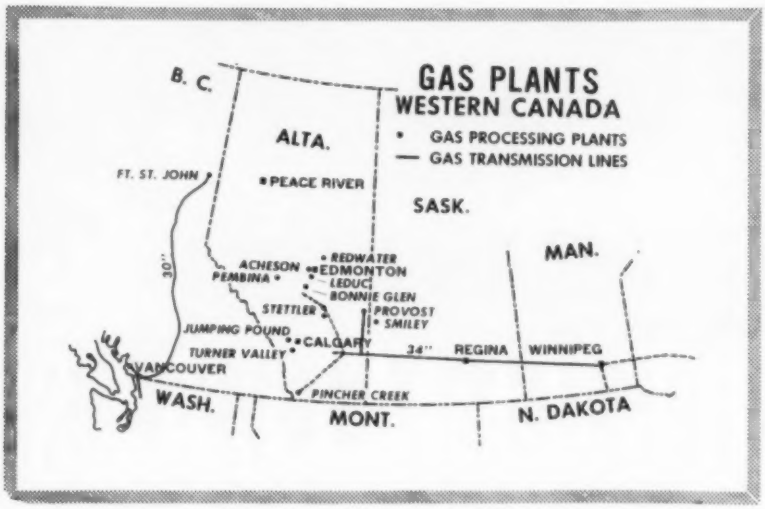
Versatility. Though low-pressure operation affords obvious advantages for many potential industrial applications, the new fuel cell isn't limited to that range. Electrical output of a given cell varies directly with pressure; should increased output be desired it could be obtained by increasing the operating pressure.

Efficiency is affected by power density — that is, at lower currents, a greater percentage of the chemical energy is converted to electricity energy. Research thus far indicates that the optimum fuel cell design will be one which will produce approximately one kilowatt of power from a packaged unit one cubic foot in volume.

Although pure oxygen is required for high current densities, a unique feature of National Carbon's cell is the ability to operate on impure fuel gases. The new design permits the use of hydrogen of standard commercial purity, or substitution of air in place of oxygen for producing small amounts of power.

Fuel cells have also been considered as a means of recovering energy from stack gas rich in carbon monoxide and water vapor. The waste gases would be reacted catalytically at the electrode surface to yield hydrogen for cell operation and CO_2. Since the latter would carbonate the caustic solution, regeneration of the electrolyte would be required.

As applied in refineries, tail gas from catalytic reforming would be the logical source of hydrogen, and at a very low cost, too. ★ ★ ★



Gas processing is scheduled to double capacity in Canada, within two years' time. Our Canadian friends know a lot about cold weather operations, too. You'll be interested to learn about . . .

GAS CONSERVATION PLANT OPERATIONS in Western Canada

George M. McPherson
Imperial Oil Company, Ltd.
Calgary, Alberta, Canada

IN INTRODUCING this subject, it might be of interest to consider the present and future scope of the gasoline plant industry in Western Canada. At the end of 1956 there were seven gasoline plants with a combined capacity of 290 MMcf per day in operation. Most of these plants are operating on oil field gas, having been built for purposes of gas conservation, and subsequent remarks on plant operations will necessarily relate to this type of plant.

We can foresee, however, a rapid expansion for the gas processing industry in general in Western Canada. By the end of 1957 there were 12 plants operating with a combined capacity of over 760 MMcf per day, and within two years' time new plants plus plant expansion presently on the drawing boards will bring the total up to at least 1600 MMcf per day.

To date, five plants in Western Canada are recovering elemental sulfur from the acid vent gases off treating units. Capacities of these sulfur plants range from 10 tons per day to over 300 tons per day. A number of large sulfur recovery plants which will operate on gases containing up to 35 percent hydrogen sulfide are currently programmed.

This impetus in plant construction stems from two large-diameter gas transmission lines which went into operation in late 1957 for the delivery of gas to other parts of Canada and to the United States. Approval for the construction of additional major pipeline outlets is now pending before various government bodies. As a result of the rigid hydrocarbon dew point specifications required by the pipeline companies, practically all of the gas to be sold into these high pressure lines will first have to be processed.

Adapted by the author from a paper originally presented at the NGAA Rocky Mountain Regional Meeting, Billings, Montana, September 25, 1957.

Types of Plants

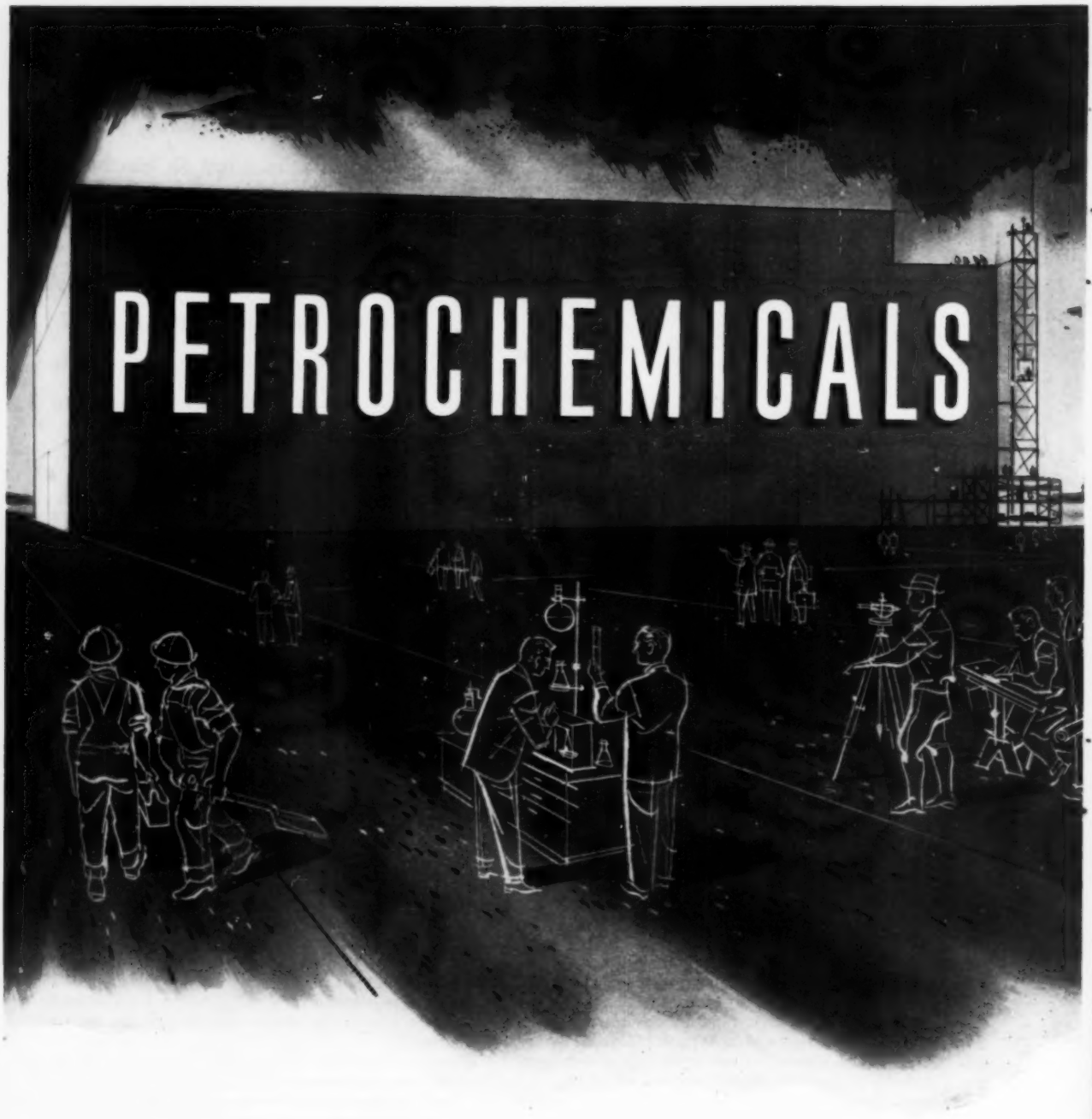
Although the major portion of the total plant capacity operating to date is represented by the absorption process, there has been in recent years a growing preference for refrigeration-type plants, particularly in the processing of oil field gas. For example, Imperial Oil Limited has constructed three oil field gas conservation plants in recent years and in all cases have utilized the refrigeration process for recovery of liquid hydrocarbons.

The reason for choosing refrigeration is not, as might logically be expected, related to the fact that the mean annual temperature for the area is only 36.5 F. We recognize that some recovery efficiency is sacrificed by using refrigeration since the minimum allowable refrigeration temperature of –20 F, as dictated by the safe working temperature of plain carbon steel, limits the propane recovery to a value less than that obtained with absorption plants.

The propane market situation has not yet reached a point where additional investment can be justified for such high recoveries. Thus, the primary function of gas processing plants, even those operating on rich oil field gases, has been to provide a specification sales gas. A propane recovery of the order of 50 to 65 percent is all that is required to meet these specifications, and under such conditions refrigeration-type plants are less costly than absorption plants. This first cost factor is perhaps of even more importance where plants are being built primarily for gas conservation purposes, rather than from a profit motive.

In addition, we have experienced a number of operating advantages to refrigeration type plants:

1. The dehydration process associated with refrigeration



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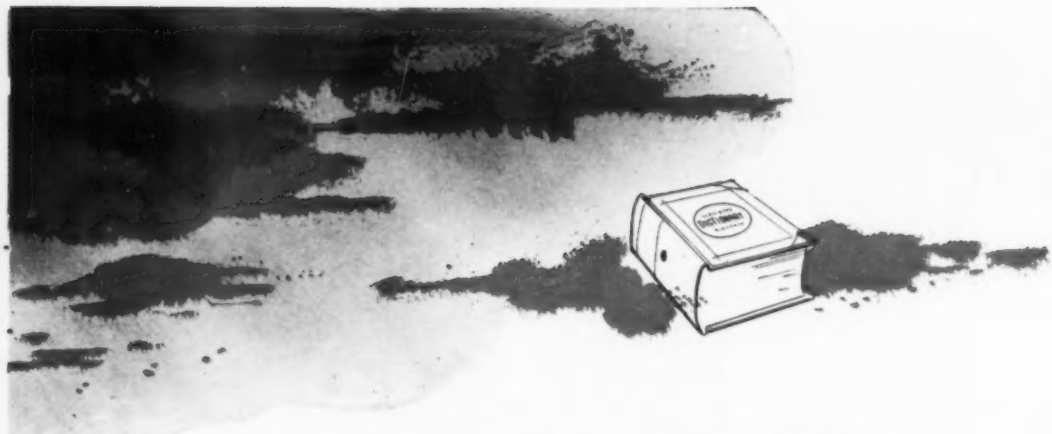

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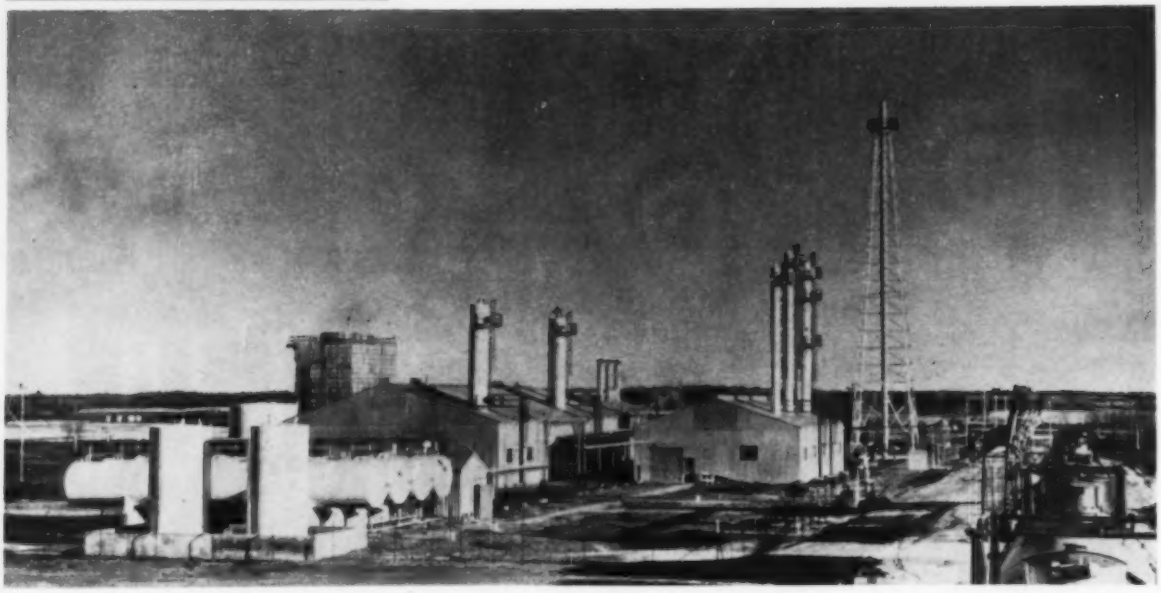


Imperial's Redwater Gas Conservation Plant processes 10,000 Mcf per day of gas to produce propane, butanes, natural gasoline, 10 tons per day of sulfur and residue gas. Note that most process equipment is enclosed for protection against severe winter temperatures.

plants is simpler and less costly. For example, the residue gas off an absorption tower is saturated with water vapor at a temperature of 80 to 110 F. To achieve a suitable water content for gas sales requires that solid desiccant dehydrating be utilized and some operators in the area have experienced difficulties with entrained absorption oil "poisoning" the solid desiccant. On the other hand, a variety of glycol dehydration systems can be employed with refrigeration-type plants.

2. Propane is usually available as a plant product and can be utilized as the refrigeration medium. Inasmuch as gas compression is always a part of oil field gas plants, by mounting the refrigerant compressor cylinder on the same machine as the gas compressor cylinders that are no extra problems to plant operations and little extra cost to the compressor installation.
3. Refrigeration-type plants, particularly when a gas fractionator is installed, allow for the flexible type of operation which is necessary due to the highly seasonable market demand for propane. Fig. 2 shows a schematic diagram of the gas fractionator and depropanizer at Imperial's Leduc plant. The indicated reflux condenser temperature of −12 F on the gas fractionator results in a propane recovery of 60 percent. During the summer months this temperature is raised to O F, reducing the propane recovery to 45 percent with little or no effect on the recovery of butanes and natural gasoline.

We have also found it necessary during the winter months to increase the vapor pressure of the propane product in order that it will vaporize out of the customers' tanks. This is accomplished by increasing the ethane content as shown in the following table:

	Summer Grade Propane	Winter Grade Propane
Ethane	3.0	4.5
Propane	95.0	95.0
Iso-butane	2.0	0.5
	100.0	100.0

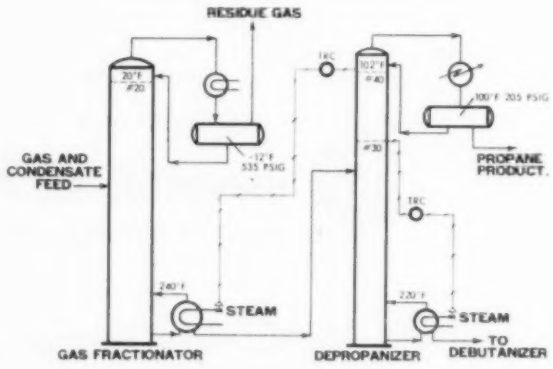
The vapor pressure of the propane product is reflected by the top tray temperature of the depropanizer, indicated on Fig. 2 to be 102 F. The amount of ethane appearing in this product is a function of the gas fractionator bottoms temperature. We can therefore set the temperature of the top tray of our depropanizer to yield the desired propane product vapor pressure, and then have this temperature-set control the amount of steam to the gas fractionator reboiler. Thus, with this type of plant it is a simple matter to vary both propane product recovery and propane product composition.

As you are undoubtedly aware, this winter vapor pressure problem is the reason butanes have not found a successful market as a domestic fuel in Western Canada. In fact, it is necessary to blanket bulk butane storage tanks with pressured gas in order that a suction head can be maintained on the shipping pumps.

Operations

Basically, gasoline plants in Western Canada are operated in a like manner to those in other regions. However, we do perhaps have some unique problems which could be discussed:

LEDUC PLANT FRACTIONATION



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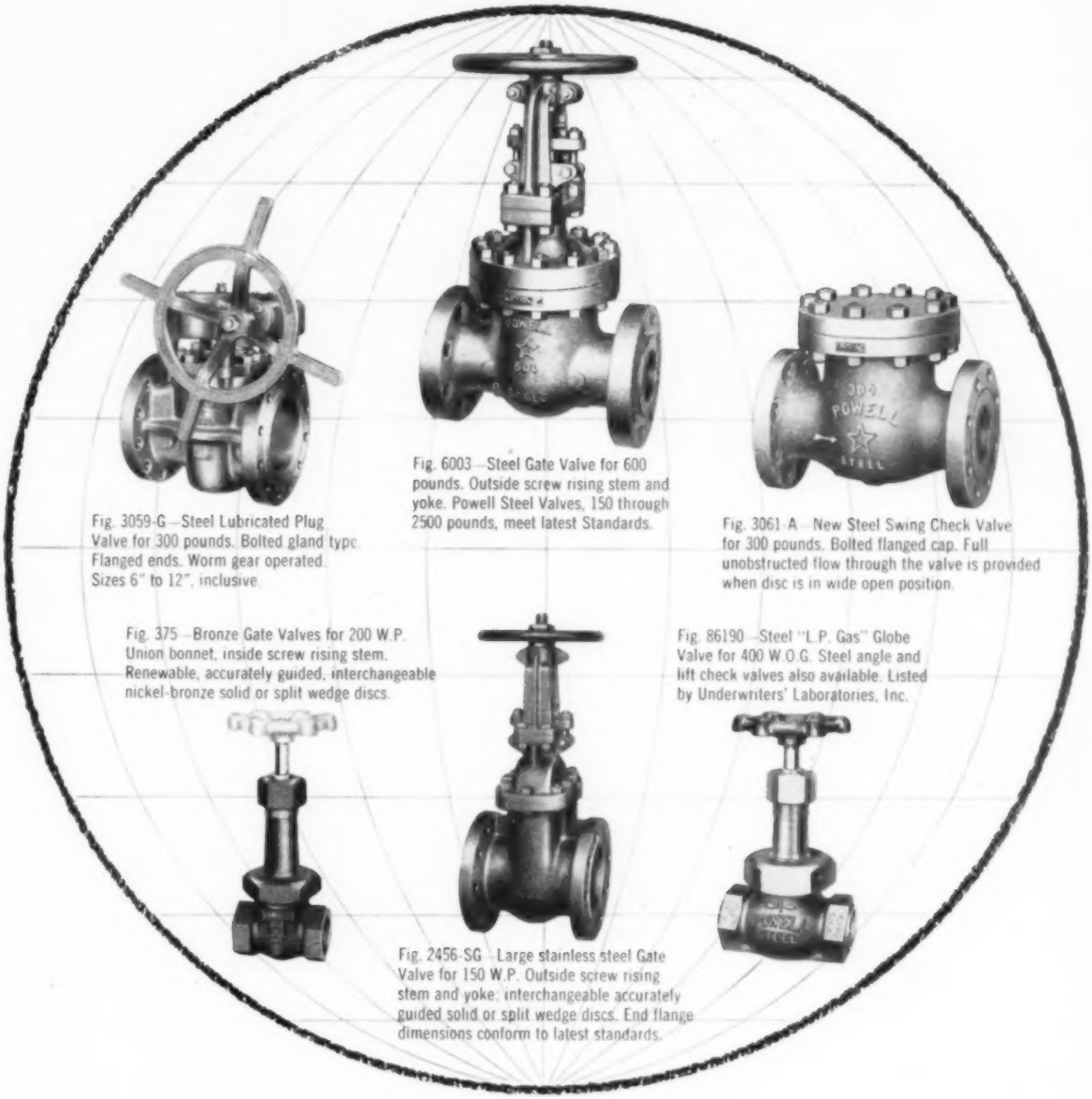

Fig. 3059-G—Steel Lubricated Plug Valve for 300 pounds. Bolted gland type. Flanged ends. Worm gear operated. Sizes 6" to 12", inclusive.

Fig. 6003—Steel Gate Valve for 600 pounds. Outside screw rising stem and yoke. Powell Steel Valves, 150 through 2500 pounds, meet latest Standards.

Fig. 3061-A—New Steel Swing Check Valve for 300 pounds. Bolted flanged cap. Full unobstructed flow through the valve is provided when disc is in wide open position.

Fig. 375—Bronze Gate Valves for 200 W.P. Union bonnet, inside screw rising stem. Renewable, accurately guided, interchangeable nickel-bronze solid or split wedge discs.

Fig. 86190—Steel "L.P. Gas" Globe Valve for 400 W.O.G. Steel angle and lift check valves also available. Listed by Underwriters' Laboratories, Inc.

Fig. 2456-SG—Large stainless steel Gate Valve for 150 W.P. Outside screw rising stem and yoke; interchangeable accurately guided solid or split wedge discs. End flange dimensions conform to latest standards.

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MODERN GASOLINE PLANTS

1. Acid Gas Removal

All plants operating in Western Canada on a sour gas feed utilize amine solutions for the removal of hydrogen sulfide and carbon dioxide. Probably the main operating problem with these units in Western Canada, as elsewhere, is corrosion. As seems to be the perverse nature of this process, some operators have experienced severe and costly corrosion problems, whereas other operators have had no difficulties. In Imperial's operations, and as a regular safeguard, we use steam condensate for amine solution makeup and specify that the amine regenerator should be designed for a reboiler temperature of not over 240 F. This latter requirement is met by utilizing low-pressure regeneration in conjunction with a lean solution of only 10 to 12 percent MEA.

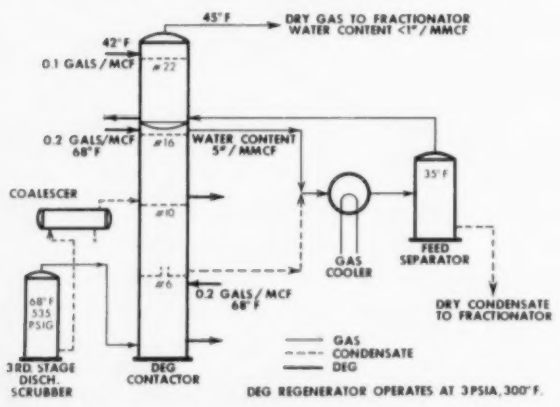
2. Dehydration

Dehydration is of particular importance in Western Canadian operations due to the rigid pipeline gas specifications resulting from the low ground temperatures at which gas must be transported during the winter months. In refrigeration-type plants, of course, any problems resulting from water vapor would first be experienced in the plant itself, since the plant process temperatures are well below any pipeline temperatures to which the gas will be subjected. Thus, to operators of refrigeration plants dehydration becomes of particular interest.

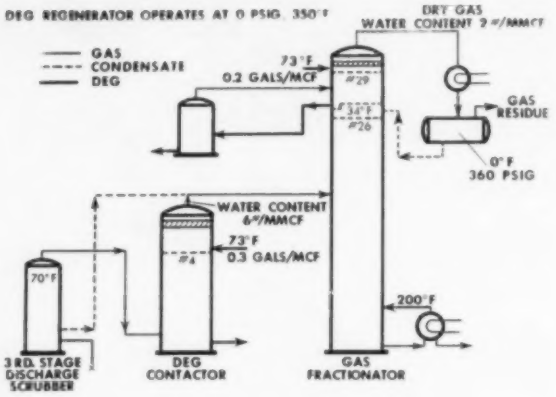
Dehydrating the gas streams presents no difficulties and a standard diethylene or triethylene glycol process provides sufficient dew point depression for subsequent refrigeration processing. However, the compressor condensate is also saturated with water which must be removed before the condensate is refrigerated. To achieve this end Imperial is using two rather novel dehydration systems.

At the Leduc plant we use diethylene glycol with a four-stage contacting column. Vacuum regeneration provides a 99 percent lean DEG. This system is shown in Fig. 3. In the bottom section of the contactor wet gas is contacted with lean DEG. In this section the gas temperature is maintained at about 2 F lower than the DEG temperature to prevent hydrocarbons from dissolving in the glycol. The dehydrated gas enters the second section of the contactor through a chimney tray and is contacted with a downcoming stream of wet compressor condensate, thus removing the water from the condensate. In the third section of the tower, the gas is again contacted with lean DEG to remove the water picked up in the previous section. The gas out of the top of this third section contains about five pounds of water per million cubic feet, which at the tower pressure of 535 lb represents a dew point of 13 F. This gas is then chilled and returned to the top section of the tower where it is contacted with chilled

LEDUC PLANT DEHYDRATION SYSTEM



REDWATER PLANT DEHYDRATION SYSTEM

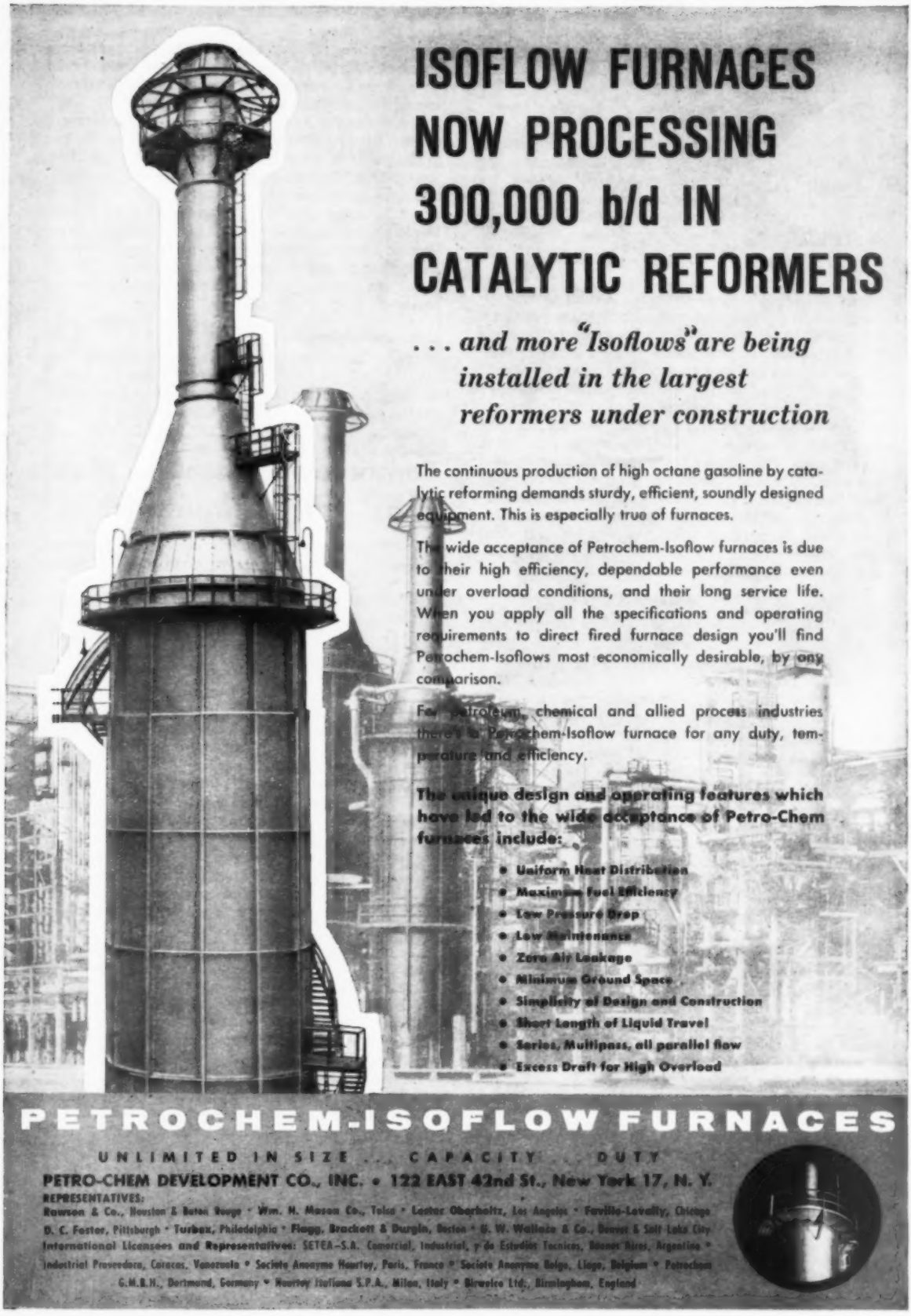


DEG to provide an off gas with a dew point of −34 F which is equivalent to a water content of less than one pound per million cubic feet. The total water removed throughout the entire contactor is about 30 lb per million cubic feet and results in glycol consumption of only one pound per million cubic feet. At a total glycol rate of 0.5 gal per Mcf this column, which is 48 in. in diameter, has handled 35 MMcf per day of gas plus 41,000 gal per day of condensate. It should be noted that the final condition of the gas is actually better than required for either the refrigeration process or for gas sales and in effect this system is somewhat more efficient than would usually be provided.

In the Redwater plant we have a somewhat simpler dehydration system, as shown in Fig. 4. The wet gas is dehydrated in a conventional diethylene glycol contactor utilizing 97.5 percent lean DEG as provided from a standard packaged-type atmospheric regenerator. This unit reduces the water content of the gas to about six pounds per million cubic feet. The dehydrated gas joins the wet compressor condensate prior to entering the gas fractionator and upon commingling with the condensate, the gas picks up the water and carries it up through the fractionator. The top tray temperature of the gas fractionator is 34 F and at high gas rates hydrates have been experienced at this point. Although this problem could be alleviated by raising the feed gas temperature which in turn raised the top tray temperature, the basic difficulty arose from insufficient settling time in the third stage compressor scrubber, which at high throughputs allowed free water to carry over with the hydrocarbon condensate. A coalescer was therefore installed in the condensate line between the third stage scrubber and the gas fractionator. Returning to the top tray of the gas fractionator it is apparent that the gas at this point is very close to being saturated with water vapor picked up from the condensate. This indicates a water content of about 17 lb per million cubic feet which would definitely cause hydrates in the reflux condenser operating at 0 F. The design therefore provides three trays of additional glycol contacting at the top of the gas fractionator which reduces the water content to two pounds per million cubic feet, or a dew point of −17 F. In spite of a wire mesh screen located at the top of this glycol section, DEG carried over to the condenser, resulting in periodic icing up of the tubes with subsequent loss in efficiency. The addition of a two-inch fiber glass pad to the wire mesh demistifier has effectively reduced this carry-over problem.

3. Winter Operation

Perhaps one of the most prominent features of a Western Canadian gas processing plant is the fact that it is almost en-



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George M. McPherson *joined Imperial Oil Limited after graduating from the University of British Columbia in 1949 with a BASc in chemical engineering. He has since been associated with the various engineering phases of evaluating and developing natural gas projects, and for the past two years has been regional gas engineer for the Producing Department, Western Region.*

tirely housed. In fact, we even provide a certain amount of maintenance and working area within compressor buildings and process buildings. Any equipment, such as portions of columns or portions of heat exchangers, which does protrude outside of the building must be thoroughly insulated, although insulation of the building itself is not necessary. The type of buildings usually used are of steel framework sheeted in with galvanized iron and in the normal gas processing plant will represent nearly 15 percent of the total direct plant costs. This cost factor becomes particularly impressive when considering the currently popular midget-size packaged plants, and we are somewhat envious of the low installed costs reported for such plants in warmer climates.

In some cases the buildings will not require any heat other than that provided by the process equipment. For example, in small compressor buildings the engine heat is sufficient, particularly if the compressor is air cooled and hot air can be directed inside the building. In this case, however, there must be provision for compressor shutdown in cold weather, such as crank case heaters in the compressors and anti-freeze compounds in any circulating cooling water.

Foundations for towers, vessels, compressors, etc., must be carried below the frost line at a depth of from 6 to 8 ft. in order to avoid frost heaving. These foundation requirements were simplified somewhat in Imperial's Smiley plant which is small enough to enable the equipment to have been consolidated on four structural steel skids. The skids have been placed on 18-in. concrete slabs, which in turn are supported by concrete piling extending below the frost line. The process in this plant includes compression, dehydration, refrigeration and the stabilization of a natural gasoline product. The plant was actually fabricated on skids in Edmonton and transported by truck some 250 miles to the Smiley site.

Cooling tower operation can be troublesome as a result of the louvres becoming encrusted with ice. Some operators utilize reversible fans and periodically blow air backward through the tower to de-ice the louvres. We use a zero pitch on the tower fans in the wintertime and simultaneously close in all the louvres on the prevailing wind side to prevent the ice from forming. In our most recent installation the louvres were built out from the side of the tower in a "doghouse" fashion which removes them from the path of the dripping water and helps to prevent the ice from forming. Water circulation should not, of course, be stopped for any appreciable time unless some means of heating the cooling tower basin is provided, nor should the cooling fans be stopped as this results in a thickening of the lubricant.

In certain chemical treatments of cooling and process water, such as lime treatment for water softening, the temperature must be kept above 50 to 60 F and heating of the water is sometimes necessary during the winter in order to maintain these temperatures.

4. **Gas Gathering**

In the operation of oil field gas gathering systems it is not usually feasible to dehydrate the gas before it enters the pipeline. These lines, and particularly those gathering gas from treaters where the gas is water saturated, are subject to freeze-offs during the winter. As a routine design precaution we provide a minimum line size of 3-in. diameter, regardless of the calculated design size. In spite of this lateral line freeze-offs in the Redwater gathering system during winter months have resulted in a considerable loss of the gas load to the plant. In some instances the lines did not clear until the month of June. It is noted that once the gas reached the larger diameter main lines no further difficulties were experienced. Although alcohol or glycol injection can loosen these blockages, we have found such remedies to be expensive. We are now experimenting with aerial cooling sections on the gas line off of the treaters in order to pre-cool the gas and knock out any free water before it enters the underground pipeline.

Acknowledgments

The author expresses thanks to G. Hollenbach, Imperial Oil Limited, engineering department, for his help in assembling data for this paper, and is also grateful to Imperial Oil Limited for the right to publish this paper. ★ ★ ★

Tomorrow's Gasoline Plants Fully Automatic?

Can a gasoline plant be designed for fully automatic, unattended operation? There's no doubt that the basic hardware is available. The pipeliners have pioneered unattended operation of gas engine-compressor units that include fully automatic sequential start-up and shut-down. It's only a matter of time before process stream analyzers that can be used to automatically control fractionator operation will be "off-the-shelf" items.

Data processing units and process computers can handle almost every routine control function that is now handled by human brains in todays "open loop" systems. And, what such fully automatic systems could not handle — save the most extreme emergencies — could be accomplished by telemetering into a central station that could conceivably handle a half dozen or more plants.

Small plants offer the most promise. There is a definite trend toward smaller plants with only a minimum of fractionation. Quite conceivably, a group of smaller plants with only absorption equipment and fractionation for lean oil recovery could supply a central fractionating plant with a C_3/ natural gasoline stream. These remote plants could be fully automatic.

Same principle has and can be applied by use of remote, unattended satellite adsorption units that would supply a central facility with raw liquid feeds.

Cost isn't the only problem. Cost alone is a tremendous deterrent to installation of equipment for moving from just one operator per shift to none. But, moving away from the cost element, the ugly problem of how to design and provide for acceptable means of handling severe emergencies such as fire arises.

One method of compromising that problem was developed by the operator of a catalytic reforming unit adjacent to a South Texas gasoline plant. While the operator works only one shift per day, warning lights and alarms are provided in his home, adjacent to the plant.

The know-how and the hardware for a plant with just one resident operator is now available, and it's probably only a matter of time before such practice will become widespread, especially in smaller and moderately-sized plants. Fully automatic operation remains a happy dream and will probably remain so except in very small operations. S.W.D.

CAA Butadiene Extraction

Licensed by: Esso Research and Engineering Company

DESCRIPTION: The Cuprous Ammonium Acetate (CAA) process is a liquid-liquid extraction process to recover high purity butadiene for use in synthetic rubber production and as a chemical intermediate. Purity of the recovered product ranges from 98.5 to 99.5 percent.

The C_4 feed mixture is extracted with CAA solvent at reduced temperature in a number of countercurrent stages. Each stage consists of a mixer and settler, with a pump to transfer hydrocarbon to the next stage. Butadiene is almost completely removed from the C_4 cut in the absorption stages. In the extract purification or "stripping" stages, the extract is freed of hydrocarbons less soluble than butadiene, namely mono-olefins and saturates. This is done by recycling part of the hydrocarbon contained in the extract stream.

Butadiene is taken overhead in the desorber, a packed or plate column equipped with a steam reboiler. Bottoms is regenerated solvent, virtually free of butadiene.

After water scrubbing, the butadiene-1,3 is rerun for removal of butadiene-1,2 and polymer.

FEEDSTOCK AND PRODUCT COMPOSITION:

Typical feeds and products are shown below. The product butadiene typically contains only 100-500 ppm of total acetylenes and is essentially free of vinyl acetylene, which is objectionable in synthetic rubber manufacture.

	Feed			Product
SOURCE OF FEED Composition, Mol %	(A) Butane Dehydrogenation	(B) Butene Dehydrogenation	(C) High Temperature Cracking of Naphthas and Gas Oils	(A), (B), or (C)
Propane and Propylene	Nil	0.2	0.1	Nil to Trace
Isobutane	2.6	11.5	—	Nil
Isobutylene	8.4	1.8	25.0	Less than 1.5
Normal Butylenes	35.6	44.5	42.4	Nil
Normal Butane	40.1	15.8	0.8	98.5 Min.
Butadiene - 1, 3	13.1	25.8	31.4	Nil
Butadiene - 1, 2	Nil	0.2	0.1	Trace
Pentanes and Pentenes	0.2	0.2	0.2	100-500
Total Acetylenes (PPM)	100	1,000	2,500	

SOLVENT: The aqueous solution of cuprous ammonium acetate absorbs butadiene by forming a chemical complex. Less stable complexes are formed with mono-olefins and none at all with saturates. The reaction is rapid and reversible, the complexes becoming less stable as temperature is raised. This allows purification of extract by countercurrent displacement of mono-olefins with butadiene, and recovery of butadiene by heating.

SERVICE FACTOR: 95+ percent.

OPERATING PERSONNEL: Three men per shift.

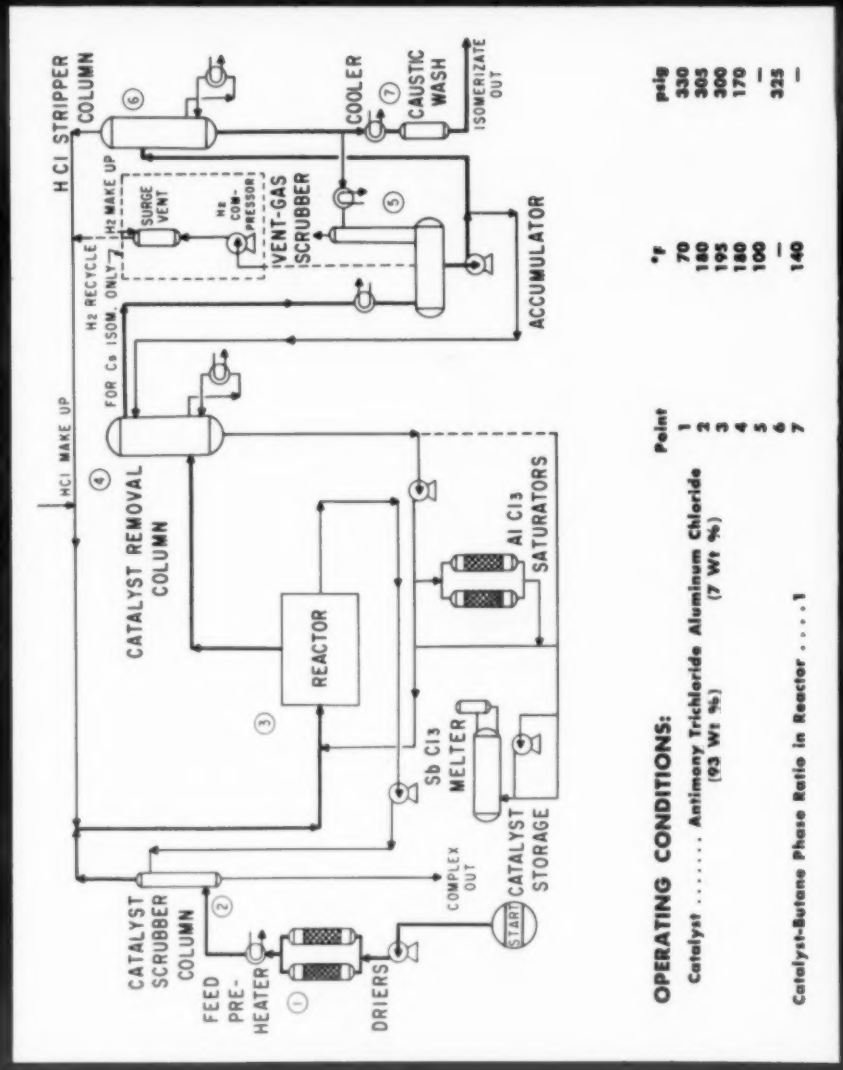
INVESTMENT AND UTILITIES: Requirements vary according to location, size of plant, feedstock analysis, recovery desired, and other factors. The figures below, for a typical plant having a capacity of 35,000 short tons per year of finished butadiene, are for orientation purposes.

Onsite Investment
(U. S. Gulf Coast) $3,000,000
Refrigeration Required ..... 1,000 tons
110 psig Steam Consumption .. 20,000 lb./hr.
Chemicals Consumed
Copper ..... 250 lb./day
Acetic Acid ..... 300 lb./day
Ammonia ..... 400 lb./day

Reference: Operations Underway at Synthetic Rubber Plant, The Refining Engineer, December 1957, Page C-7.

Liquid-Phase Butane Isomerization-II

Licensed by: Shell Development Company



Liquid-Phase Butane Isomerization-II

Licensed by Shell Development Company

DESCRIPTION: This butane isomerization process requires only one reactor of a new design, as compared to the earlier form of the process, which used three stirred reactors. Substantially higher conversion of normal butane to isobutane is claimed, and investment and operating costs are much reduced.

Normal butane is contacted in the reactor with liquid catalyst consisting of a solution of aluminum chloride in antimony trichloride. Anhydrous hydrochloride is added to the mixture as a promoter. The reaction produces isobutane with hardly any products boiling outside the butanes.

Dried normal butane, heated to about 180°F, is passed through the catalyst scrubber and charged to the reactor vessel. A small sidestream of catalyst from the reactor is contacted with the heated feed in the catalyst scrubber to recover $AlCl_3$ and $SbCl_3$, leaving only a small amount of sludge which is rejected periodically from the bottom of the scrubber.

Simple fractionation removes catalyst from the isomerizate from the third reactor vessel. Recovered catalyst is recycled to the first reactor vessel. Following light ends removal and HCl stripping, the isomerizate is cooled and caustic washed.

FEED SPECIFICATIONS:

	Recommended Maximum
Unsaturates	0.05 Mol %
Sulfur	0.005 Wt. %
Water	0.001 Wt. %
iC_5+	1.0 Mol %

TYPICAL MATERIAL BALANCE:

	Feed		Product	
	Wt. %	Vol. %	Wt. %	Vol.%
C_3	.....	.....	.05	0.06
iC_4	5.00	5.18	60.50	61.47
nC_4	94.65	94.50	37.79	36.99
iC_5+	.35	.32	1.61	1.48
Loss	.....	.....	0.05	.....
	100.00	100.00	100.00	100.00

UTILITIES AND CHEMICALS:

	Per B Net Isobutane
Steam (100 psig)	180 lb
Cooling water (30°F rise)	560 gal
Power	1.3 kwh
$AlCl_3$	0.10 lb
$SbCl_3$	0.04 lb
HCl	0.04 lb
NaOH	0.01 lb

SERVICE FACTOR: 95 Percent

CAPITAL COST: Bare equipment for a 1,000 BPD isobutane plant is estimated to cost about $160,000, excluding contingency.

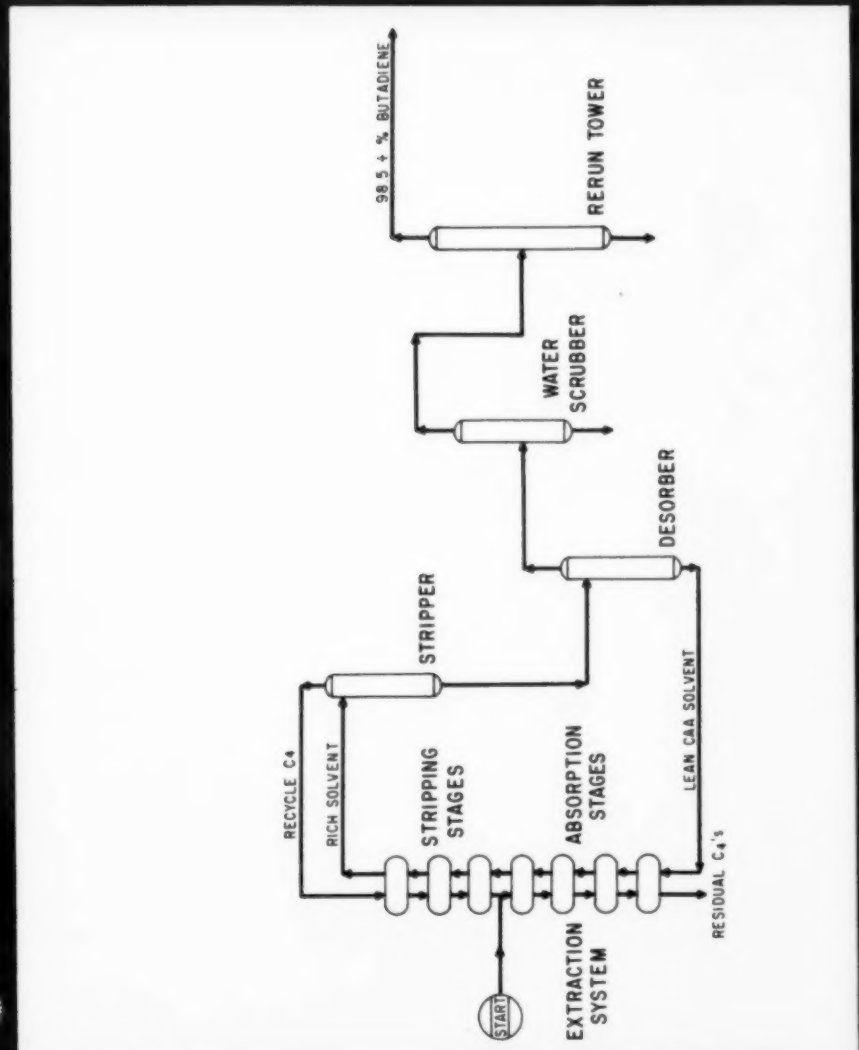
ROYALTIES:

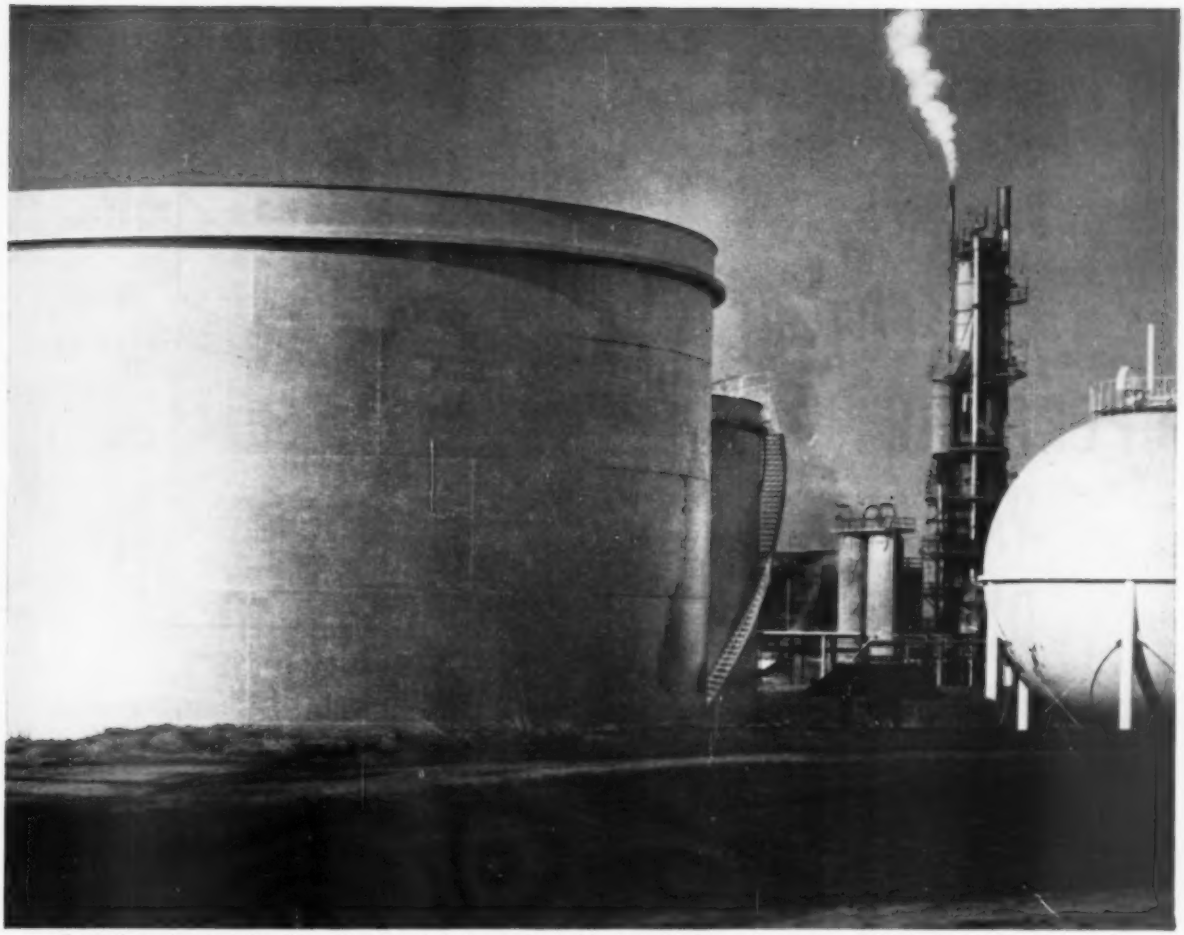
Running: 10¢/B Net iC_4 Made
(5¢/B if Sale to U.S. Gov't.)

Paid-up: 50¢/Annual B Net iC_4 Prod. Cap'y.

CAA Butadiene Extraction

Licensed by Esso Research and Engineering Company





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EFFECT OF OPERATING VARIABLES ON COOLING TOWER PERFORMANCE

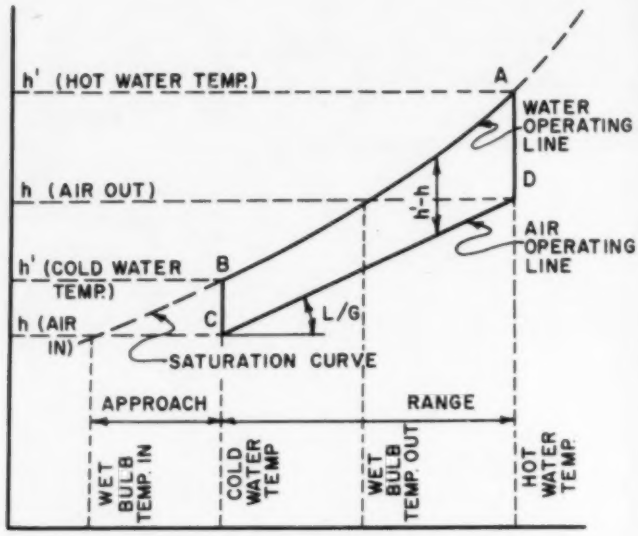


FIG. 1. **Cooling Tower Heat Balance.**

Maxey Brooke, *Sweeny, Texas*

MANY ARTICLES about cooling towers have been written for the benefit of design engineers. When a tower has been built and put into operation, the responsibility of the design engineer ceases. But the operating engineer must work with the tower for the duration of its life. If the tower continued to operate under design conditions, he could use the same data as the design engineer. Unfortunately, these conditions seldom exist.

Operations change — The operating engineer is faced with a variety of problems that could not be anticipated during the design of the tower. Among them are:

1. The heat load on the tower is increased either because new units are added to the plant which it services, or the old ones are operated at greater than design capacity.
2. Unusual weather imposes higher wet bulb temperatures for longer periods than those for which the tower was designed.
3. Mechanical wear and/or failures often make it necessary to operate the tower with lower air and/or water flows than those for which the tower was designed.
4. Changes in plant operation sometimes makes it necessary to produce a cold water temperature below design conditions.

Effect on performance — The operating engineer must know what effect these operating changes will have upon the cooling tower's performance. He must also be able to predict the capabilities of the tower under changed conditions.

Before examining the effect of operating variables, it is well to review the theory of cooling tower operation.

The heat balance around a mechanical draft cooling tower can be represented by the equation

$$Gdi_G = Lc_p dt_L + c_p dL\,(t_L - t_o) \quad (1)$$

If the second term on the right can be ignored and L assumed constant

$$Gdi_G = Lc_p dt_L \text{ (nearly)} \quad (2)$$

The mass balance around the tower is

$$Gdi_G = Ka(i_L - i_G)\,dV \quad (3)$$

Substituting Equation 1 in Equation 3

$$Lc_p dt_L = Ka(i_L - i_G)dV \quad (4)$$

Solving Equation 4 and integrating with $c_p = 1.0$ for water

$$\frac{KaV}{L} = \int_{t_1}^{t_2} \frac{dt_L}{i_L - i_G} \quad (5)$$

The left side of Equation 5 has been named the "tower characteristic."

This process is represented graphically in Fig. 1. The saturation curve on this diagram shows the relationship between the temperature and enthalpy of saturated air. Data for constructing this curve is given in Table 1.*

This curve applies to the air film surrounding the water and so becomes the water-operating line, limited by the hot-and-cold-water temperatures, points A and B. The origin of the air-operating line, point C, is vertically below B and positioned to have an enthalpy corresponding to that of the entering wet bulb temperature. The ver-

*Also see "Tables Speed Cooling Tower Calculations" by Maxey Brooke, *The Refining Engineer*, Vol. 29, No. 12, p C-23, November, 1957.

TABLE 1. Enthalpy of Moist (Saturated) Air.

Wet bulb temp., F	Btu per lb	Wet bulb temp., F	Btu per lb
30	10.92	78	41.58
32	11.76	80	43.69
34	12.59	82	45.90
36	13.44	84	48.22
38	14.32	86	50.66
40	15.23	88	53.23
42	16.17	90	55.93
44	17.15	92	58.78
46	18.16	94	61.77
48	19.21	96	64.92
50	20.30	98	68.23
52	21.44	100	71.73
54	22.62	102	75.42
56	23.84	104	79.31
58	25.12	106	83.42
60	26.46	108	87.76
62	27.85	110	92.34
64	29.31	112	97.18
66	30.83	114	102.31
68	32.42	116	107.73
70	34.09	118	113.46
72	35.83	120	119.54
74	37.66	125	136.4
76	39.57	130	155.9

tical distance B-C represents the initial driving force $(i' - i)$. As the water is cooled one degree, the enthalpy of the air is increased one Btu multiplied by the ratio of pounds of water per pound of air, so the L/G ratio is the slope of the operating line. Point D, representing the air leaving the cooling tower, is the point on the air-operating curve vertically below point A. The projected length C-D is the cooling range. The coordinates refer directly to the temperature and enthalpy of any point on the water-operating line but refer directly only to the enthalpy of a point on the air-operating line. The corresponding wet bulb temperature of any point on C-D is found by projecting the point horizontally to the saturation curve, then vertically to the temperature coordinate.

The integral $\int_{t_1}^{t_2} \frac{dt_L}{i_L - i_G}$ is represented by the area ABCD in the diagram. This value is a characteristic of the tower varying only with the L/G ratio.

For example, an increase in entering wet bulb temperature moves the origin C upward and the line C-D shifts to the right to maintain a constant KaV/L. Or, if the cooling range increases, line C-D lengthens. At a constant wet bulb temperature, equilibrium is established by moving the line to the right to maintain a constant KaV/L.

On the other hand, a change in the L/G ratio changes the slope of C-D and the tower comes to equilibrium with a new KaV/L. The relation between these two values is such that they plot as a straight line on log-log paper.

"Tower characteristic." It is necessary to know the "tower characteristic" of any given tower in order to predict its performance. This is rather difficult to do with the information given in the theory. Woods and Betts *(The Engineer,* London, March 17 and 24, 1950) have prepared a nomograph, Fig. 2, from which KaV/L can be easily determined.

Assume a tower operating with a 20 F range, a cold water temperature of 80 F, and at 70 F wet bulb. A straight line may be drawn through the chart connecting these values. If L/G is calculated to be 1.00, a KaV/L may be determined by a line through L/G = 1.00 and parallel to the given line. KaV/L = 1.42. If the wet bulb temperature drops to 50 F, L/G and KaV/L can be assumed to remain constant. A new line parallel to the original will show that for the same range, the cold water temperature will drop to 70 F.

Here are four sets of data taken on the same cooling tower under different operating conditions:

	1	2	3	4
Hot water temperature, F	104	97	104	108
Cold water temperature, F	92	83	88	89
Wet bulb temperature, inlet air, F	77	62	72	76
Temperature, air out, F	96	88	95	99

From these data, the L/G ratio can be calculated from the formula

$$\frac{L}{G} = \frac{\text{Enthalpy (air in} - \text{air out)}}{\text{Temp. (water in} - \text{water out)}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The enthalpy values from Table 1 are used

Test	L/G
1	2.03
2	1.90
3	1.72
4	1.60

From these values, the KaV/L can be taken from Fig. 2.

Test	L/G	KaV/L
1	2.03	0.88
2	1.90	1.00
3	1.72	1.20
4	1.60	1.30

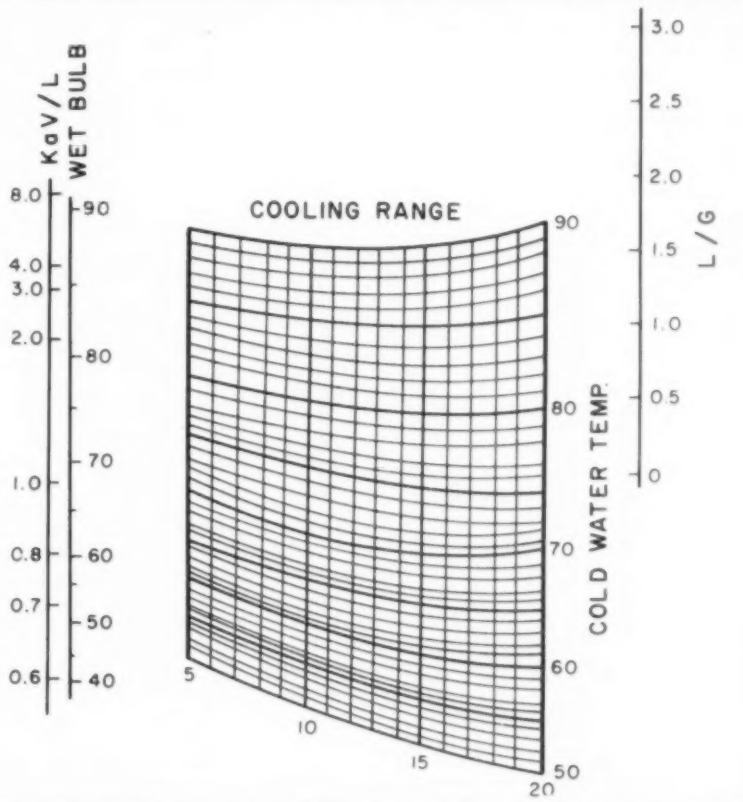


FIG. 2. **Calculation** of KaV/L Factors.

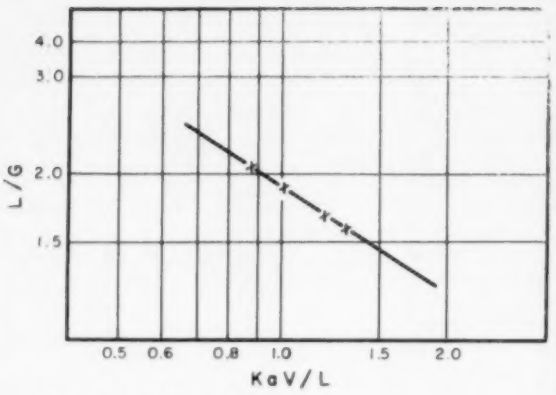


FIG. 3. **Relation of L/G to KaV/L.**

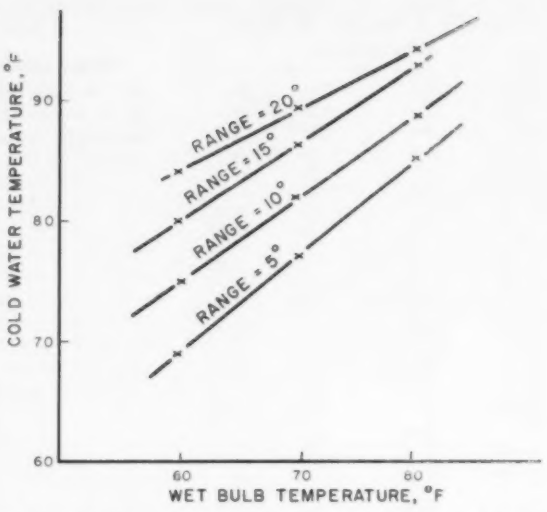


FIG. 4. **Variation of cold water temperature with wet bulb temperature L/G = 1.75.**

If L/G is plotted against KaV/L on log-log paper, a straight line with a slope of approximately 0.5 results. In this example the slope is 0.65.

It is now possible to predict the performance of the tower under any operating condition. Since this tower operates with L/G ratios of between 1.5 and 2.0, these two values and an intermediate value of 1.75 will be used. From Fig. 3, the KaV/L values corresponding to the L/G ratios are

L/G	KaV/L
1.50	1.45
1.75	1.08
2.00	0.91

Three standard wet bulb temperatures 60, 70, and 80 F and four standard ranges, 5, 10, 15 and 20 F are selected. From Fig. 2, the cold water temperatures can be determined for each of the 45 values. These values are tabulated below.

L/G=2.00			L/G=1.75			L/G=1.50		
WB	CW	R	WB	CW	R	WB	CW	R
60	71.0	5	60	69.0	5	60	66.0	5
60	77.0	10	60	75.0	10	60	72.0	10
60	82.0	15	60	80.0	15	60	76.0	15
60	86.0	20	60	84.0	20	60	78.0	20
70	79.0	5	70	77.0	5	70	75.0	5
70	84.0	10	70	82.0	10	70	80.0	10
70	88.0	15	70	86.5	15	70	82.0	15
70	91.0	20	70	89.5	20	70	83.0	20
80	86.0	5	80	85.5	5	80	83.0	5
80	91.0	10	80	89.0	10	80	86.0	10
80	94.5	15	80	93.0	15	80	88.5	15
80	96.0	20	80	94.0	20	80	88.0	20

Predicting performance — Unfortunately there is no one simple method of showing all this data on one graph. It will be necessary to make several or to choose the variable in which you are interested. For example, Fig. 4 shows the variation of cold water temperatures with the wet bulb temperature at various cooling ranges for a cooling tower with a L/G ratio of 1.75 and a KaV/L of 1.08. Other such charts can be drawn as desired.

At first glance, it might seem that some of the variables are neglected. But they can be calculated. For example: Hot water temperature = cold water temperature + range; Approach = cold water temperature — wet bulb temperature.

Recapitulation — The steps necessary to predict the performance of a mechanical draft cooling tower are:

1. For at least three operating conditions, determine the following temperatures.
   a. Hot water
   b. Cold water
   c. Atmospheric wet bulb
   d. Exhaust air
2. Calculate the L/G ratio for each condition by Equation 6.
3. Determine the KaV/L for each L/G ratio by Fig. 2.
4. Plot L/G vs KaV/L on log-log paper. A straight line should result.
5. Select standard L/G ratios, ranges, and wet bulb temperatures. Determine cold water temperatures from Fig. 2.
6. Plot selected variables to determine tower performance under new conditions.

Finally, the qualitative effect of the variables is tabulated below. * * *

Nomenclature

- a = area of transfer surface per unit of volume, sq ft/cu ft
- c_p = heat capacity, Btu/(lb) (F)
- G = gas mass velocity, lb dry air/(hr) (sq ft cross section)
- i = enthalpy of mixture of air and water vapor, Btu/lb dry air; i_L at t_L, i_G at t_g
- L = water mass velocity, lb/(hr) (sq ft cross section)
- t = bulk temperature, F; t_G for gas temperatures, t_L for liquid temperatures
- V = volume of tower, cu ft.

An increase in this variable	Will cause the following change in this variable				
	L/G	Range	Approach	KaV/L	Temp. air out
Heat load	None	Increase	Increase	Decrease	Increase
Air rate	Decrease	None	Decrease	Increase	Decrease
Water rate	Increase	None	None	Decrease	None
Wet bulb	None	None	Decrease	None	Increase

Ohio University's executive development program is an intensive, four-week study for 30 participants . . .

Thirty executives listen to management teacher.

Use Case Discussion Technique

E. T. Hellebrandt

OHIO UNIVERSITY Executive Development program, held in Athens, Ohio, is designed to give a group of 30 business executives time to study together intensively for a month. The program assists participants to become better executives when they return to their jobs and thus help meet the need for more broadly-trained personnel.

Such study also helps to broaden the outlook of the individual participant by giving him: (1) An appreciation of his responsibilities in community, state, and national affairs; (2) A better understanding of other areas of management outside his own specialty; (3) Improvement in his ability to think through problems that confront him in his job, whatever they may be.

In its fourth year, the program is conducted by the case study and discussion method with guest speakers from business and education. Participants attend three business classes each day except Saturday, when only two classes are conducted and classes end at noon. The business classes are one and one-half hour sessions. A fourth session, three times a week, is offered in public speaking or rapid reading for the individual participant's personal development.

Areas covered include: (1) Distribution (marketing, advertising, retailing); (2) Human relations; (3) Labor and collective bargaining; (4) Financial control; (5) Production, and (6) Business policy.

The case study and discussion method is most effective when the participants are well grounded and prepared in the facts of each case. One factor contributing to the effectiveness of this Executive Development program is the use of study groups made up of five or six participants who, under the leadership of a faculty member, each evening discuss the cases that will be considered the following day. These groups are regrouped every four days to permit contact with all members and instructors.

At midpoint, wives of the participants are invited to the campus for a weekend of activities. This includes a human relations case discussion specially prepared for them and conducted by one of the faculty. In this way, the wives come to appreciate more fully the experience of their husbands. During the rest of the weekend, a recreational program is provided.

Size of the group is limited to 30 participants, not more than two of whom may come from any one company, selected from as wide a variety of industry and position backgrounds as possible. Since this is essentially a middle-management program, men selected are in the 35 to 45 age group with 10 to 15 years of business experience.

College degrees are not a prerequisite for this program. It is suggested, however, that companies nominating men for the program select those individuals whose potential has been fairly well established and who appear to be good prospects for top management positions.

Dr. Karl H. Krauskopf, acting dean of the College of Commerce, is director of the program, and the core faculty is made up of senior professors from Ohio University and guest speakers and faculty, who have included: E. J. Laueson, chairman, Executive Committee, Fuller, Smith & Ross, Inc.; J. W. Newman, professor, Harvard University, Graduate School of Business Administration; Dr. J. LeRoy Thompson, educational service director, Wall Street Journal; Dr. O. A. Ohmann, director, Organization Planning and Management Development, The Standard Oil Company (Ohio); Dr. Keith Davis, professor of management, Indiana University.

Participants are housed in a new dormitory, Voigt Hall, across the street from the air conditioned University Center Building in which most classes are held and where luncheon and dinner are served in a private dining room. Breakfast is in the Center cafeteria. Recreational facilities include the air conditioned recreation room and bowling alleys in the Center Building, the University swimming pool, a nine-hole golf course, and performances of the Ohio Valley Summer Theatre.

Participants in previous programs have come from all sections of the United States and from Manila, Philippines. Companies represented have included electric and gas utilities, grocery chain, manufacturing industry, oil, paper, glass, ceramic tile, office machinery, insurance and military installations.

The next course will be held from July 6 through August 2, 1958.

Cost of the entire four-week period is $700, which includes board, room, tuition, and all instructional materials. It is assumed that the companies will bear the entire cost. Registration may be made by addressing: Dean Karl H. Krauskopf, College of Commerce, Ohio University, Athens, Ohio. * *

Mr. Hellebrandt is chairman, department of management, Ohio University, College of Commerce, Athens, Ohio.

CALCULATE PIPE STRESSES EFFICIENTLY

Method given here is based on the new ASA Code for pressure piping. Here are ways to save time and labor in designing piping systems

Part 1. *Calculating Forces for a Three-Dimensional System*

K. Hao Hsiao
Consultant, Pasadena, California

PIPING SYSTEMS, as part of the equipment of modern pipeline stations, chemical plants, and refineries, are subjected to high temperatures, pressures and corrosive conditions. Thus, in order to prevent failure of equipment and withstand the great stresses due to thermal expansion, piping stress analysis has become increasingly important.

Piping stress calculation by conventional procedure is a tedious process, prone to error: The analyst must face the monotony and labor of computing many rows and tables of figures, and go through the mechanical routine of solving simultaneous equations for each piping system. A fatal error in signs, which would require complete repetition of calculations must be avoided.

The methods presented here are based on the 1955 American Standard Code for Pressure Piping. This code contains the following significant changes for previous codes:

1. Application of flexibility factor K and the stress intensification factor i (applied to all three perpendicular planes instead of only the plane of the elbow).
2. The formulas and calculation of: The above factors K and i; characteristic factor h; allowable stress range; maximum expansion stress (controlling stress range); and hot and cold reactions.
3. The phenomenon of self-springing.

The procedures in this and future chapters are for efficient, time-saving tabulation and calculation of forces, moments and stresses in (a) three-dimensional systems containing elbows, (b) single-plane system subjected to expansion perpendicular to its own plane, (c) single-plane system with expansion in its own plane, and (d) square-cornered system, systems containing mitres, and systems containing piping of different diameters.

Three-Dimensional Piping Systems

Consider the following piping system:

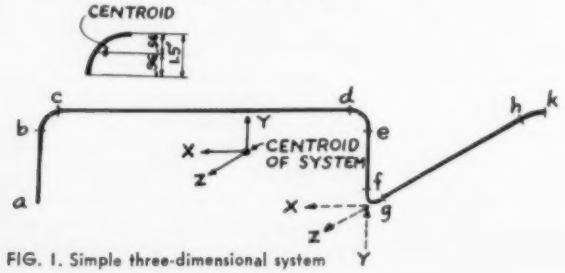


FIG. 1. Simple three-dimensional system

Assume end "a" as fixed and end "k" as tending to expand.[1] Then, the forces X, Y, and Z, which restrain the end "K" and prevent it from expansion, are transferred to the centroid of the system (behind abcdf plane), forming the centroidal axes of the system. In actual computation, however, the original axes are used instead of the centroidal axes.

As shown by dotted lines in Fig. 1, the original arbitrarily chosen axes are such that two of the axes are in a plane containing the greatest number of branches, while the third axis is co-linear with a branch perpendicular to this plane. Such a selection reduces many coordinate values in Table 1 to zero, thereby cutting down the time and labor required for calculations. The X, Y, and Z forces are obtained from the following equations:[2]

$$XI_x - YI_{xy} - ZI_{xz} = \frac{\Delta xEI}{1728} \quad . \quad . \quad . \quad (1)$$

$$-XI_{xy} + YI_y - ZI_{yz} = \frac{\Delta yEI}{1728} \quad . \quad . \quad . \quad (2)$$

$$-XI_{xz} - YI_{yz} + ZI_z = \frac{\Delta zEI}{1728} \quad . \quad . \quad . \quad (3)$$

Dividing Equations 1, 2, and 3, by line inertias I_x, I_{xy}, and I_{xz} respectively, and using E_c for E, according to the 1955 ASA Code for Pressure Piping, we obtain:

$$X - Y\frac{I_{xy}}{I_x} - Z\frac{I_{xz}}{I_x} = \frac{\Delta_x E_c I}{1728\, I_x} \quad . \quad . \quad . \quad (4)$$

$$-X + Y\frac{I_y}{I_{xy}} - Z\frac{I_{yz}}{I_{xy}} = \frac{\Delta_y E_c I}{1728\, I_{xy}} \quad . \quad . \quad . \quad (5)$$

$$-X - Y\frac{I_{yz}}{I_{xz}} + Z\frac{I_z}{I_{xz}} = \frac{\Delta_z E_c I}{1728\, I_{xz}} \quad . \quad . \quad . \quad (6)$$

Calculation of Line Inertias

The calculation of line inertias in Equations 4, 5, and 6 is based on Equation 7, and the operations are tabulated in Table 1 (See Example 1). The solution for X, Y, and Z forces is also given in Table 1. The calculations of coordinates $\bar{x}$ and $\bar{y}$ of the centroid of the system in XY plane with respect to the original axes are based on the last two equations in Equation 7 and those in other planes are obtained in a similar manner.

[1] All piping systems in this paper are assumed to be fixed at both ends (for flexibility) where forces, moments and torques occur. However, one end of each system is shown as temporarily free to expand in order to determine the directions of forces X, Y, and Z resisting expansion at that end. These forces are transferred to the centroid of system, where there is no moment or torque.

[2] Spielvogel, W. S., "Piping Stress Calculations Simplified."

Equation 7.

PLANE	EQUATION

XY $$I_x' = \alpha \sum_{i=\text{all elbows}} y_i^2 + \beta \sum_{i=\text{elbows} \parallel \text{plane}} y_i^2 + \sum_{i=\text{all branches}} L_i y_i^2 + 0.3 \sum_{i=\text{branches} \perp \text{plane}} L_i y_i^2 - \bar{y} \left[\alpha \sum_{i=\text{all elbows}} y_i + \beta \sum_{i=\text{elbows} \parallel \text{plane}} y_i + \sum_{i=\text{all branches}} L_i y_i + 0.3 \sum_{i=\text{branches} \perp \text{plane}} L_i y_i \right]$$

YZ $I_z'' =$ SAME AS ABOVE

XY $$I_y' = \alpha \sum x_i^2 + \beta \sum x_i^2 + \sum L_i x_i^2 + 0.3 \sum L_i x_i^2 - \bar{x} \left[\alpha \sum x_i + \beta \sum x_i + \sum L_i x_i + 0.3 \sum L_i x_i \right]$$

XZ $I_z' =$ SAME AS ABOVE

XZ $$I_x'' = \alpha \sum z_i^2 + \beta \sum z_i^2 + \sum L_i z_i^2 + 0.3 \sum L_i z_i^2 - \bar{z} \left[\alpha \sum z_i + \beta \sum z_i + \sum L_i z_i + 0.3 \sum L_i z_i \right]$$

YZ $I_y'' =$ SAME AS ABOVE

ENTIRE SYSTEM $$I_x = I_x' + I_x'' + \frac{I_1}{12} + \frac{I_2}{12}$$

ENTIRE SYSTEM $$I_y = I_y' + I_y'' + \frac{I_1}{12} + \frac{I_3}{12}$$

ENTIRE SYSTEM $$I_z = I_z' + I_z'' + \frac{I_2}{12} + \frac{I_3}{12}$$

XY $$I_{xy} = \alpha \sum_{i=\text{all elbows}} x_i y_i + \beta \sum_{i=\text{elbows} \parallel \text{plane}} x_i y_i + \sum_{i=\text{all branches}} L_i x_i y_i + 0.3 \sum_{i=\text{branches} \perp \text{plane}} L_i x_i y_i - \bar{y} \left[\alpha \sum_{i=\text{all elbows}} x_i + \beta \sum_{i=\text{elbows} \parallel \text{plane}} x_i + \sum_{i=\text{all branches}} L_i x_i + 0.3 \sum_{i=\text{branches} \perp \text{plane}} L_i x_i \right]$$

XZ $$I_{xz} = \alpha \sum x_i z_i + \beta \sum x_i z_i + \sum L_i x_i z_i + 0.3 \sum L_i x_i z_i - \bar{z} \left[\alpha \sum x_i + \beta \sum x_i + \sum L_i x_i + 0.3 \sum L_i x_i \right]$$

YZ $$I_{yz} = \alpha \sum y_i z_i + \beta \sum y_i z_i + \sum L_i y_i z_i + 0.3 \sum L_i y_i z_i - \bar{z} \left[\alpha \sum y_i + \beta \sum y_i + \sum L_i y_i + 0.3 \sum L_i y_i \right]$$

where $\alpha = \left(\frac{K+1}{2}\right) L_a$ $\beta = \left(\frac{K-1}{2}\right) L_a$

XY $$\bar{y} = \left[\alpha \sum_{i=\text{all elbows}} y_i + \beta \sum_{i=\text{elbows} \parallel \text{XY}} y_i + \sum_{i=\text{all branches}} L_i y_i + 0.3 \sum_{i=\text{branches} \perp \text{XY}} L_i y_i \right] \div \left[\alpha N + \beta N_{xy} + \sum_{i=\text{all branches}} L_i + 0.3 \sum_{i=\text{branches} \perp \text{XY}} L_i \right]$$

XY $$\bar{x} = \left[\alpha \sum_{i=\text{all elbows}} x_i + \beta \sum_{i=\text{elbows} \parallel \text{XY}} x_i + \sum_{i=\text{all branches}} L_i x_i + 0.3 \sum_{i=\text{branches} \perp \text{XY}} L_i x_i \right] \div \left[\alpha N + \beta N_{xy} + \sum_{i=\text{all branches}} L_i + 0.3 \sum_{i=\text{branches} \perp \text{XY}} L_i \right]$$

TABLE 1. Moments and Products of Inertia; Forces.

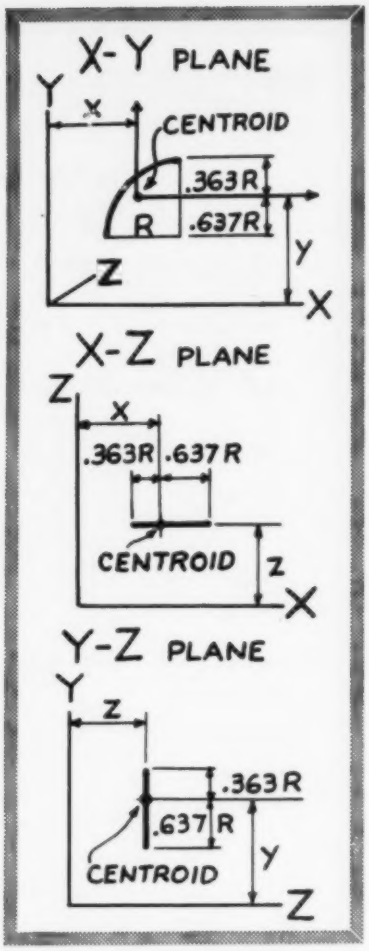


FIG. 2. An elbow parallel to XY plane.

For clarity of presentation, the subscript "i" is defined only over the summation signs for I'_x and I_{xy} and are meant (but not repeated) for terms below them.

It is seen, from the above equations, that the numerical values for branches in torsion in each perpendicular plane ("branches $\perp$ plane") is increased 30 percent to take into account their torsional effect on flexibility. Such increases in flexibility are tabulated in rows (2), (4), and (6) in Table 1.

When a piping system contains circular 90-deg elbows or quarter bends, each of these elbows contributes greater flexibility in bending than that of its true length to the system. This increased flexibility of elbow is accounted for by using a Virtual Length "KL_a," which is used in calculating line inertias in the plane of elbow. The flexibility factor "K" and the actual length of elbow "L_a" are defined below, with the condition that $K > 1$.

$$K = \frac{1.65}{h} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$L_a = \frac{\pi R}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Where the characteristic factor "h" is

$$h = \frac{12tR}{r^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

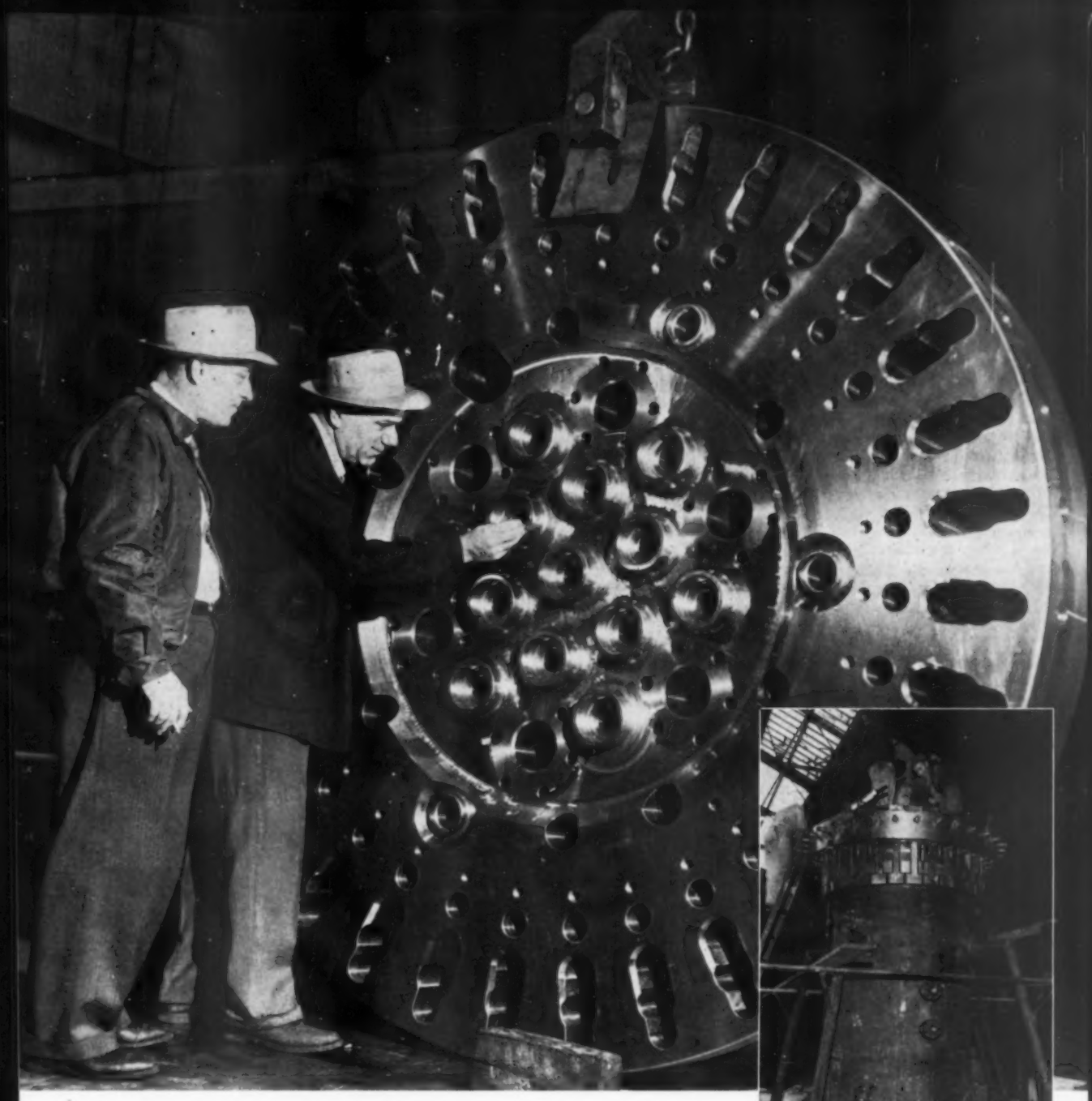
For example, for the elbow shown in Fig. 2, "KL_a" is its virtual length in calculations for line inertias in XY plane.

The elbow in Fig. 2 is completely in bending in XY plane and only partially so in XZ and YZ planes, i.e., the elbow is half in bending and half in torsion in the latter two planes. Since the flexibility factor for an elbow in torsion is unity,[3] its virtual lengths in XZ and YZ planes are $\left(\frac{K+1}{2}\right) L_a$.

The equation for I'_x in XY for all elbows in the entire piping system then takes the form shown on the following page (equation 11).

Combining Equation 11 with I'_x for the straight branches in the system, we have the expression for I'_x in Equation 7. The sum of increases in flexibility for elbows in their own plane XY, i.e., $\beta \sum_{i=\text{elbows}\,\parallel\,XY} y_i^2$ is tabulated in row (8), and those in the other two planes are in rows (10)and (12). The numerical values in rows (2), (4), (6), (8), (10), and (12) result in the different final values for each plane, tabu-

[3]Some experts advocate the use of factor 1.3, which is the same as the flexibility factor for a straight branch in torsion. Before the publication of the 1955 ASA Code for Pressure Piping, piping engineers used (1) a smaller value of K at a low h value for in-plane bending of elbow, (2) factor of unity for transverse bending, and (3) factor of 1.3 for torsion; hence, the virtual length was KL_a and transverse virtual length was $\left(\frac{1+1.3}{2}\right) L_a = 1.15L_a$.



This pressure vessel had to be designed with a closure that would open or close in 30 minutes, and withstand 1500 psi, 500F. Made of Type 304 stainless, the closure has 34 pipe connections, with many holes bored to tolerances of .002 in.

FOR NUCLEAR NEEDS of Knolls Atomic Power Laboratory, M.W. Kellogg was given the exacting assignment of designing and fabricating this complex closure for a "Proof Test Reactor Pressure Vessel." Kellogg also fabricated the complete 32½-ton unit. If these specialized skills suggest a solution to a difficult problem in nuclear equipment or chemical processing equipment, call Kellogg's Fabricated Products Sales Division.

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M KELLOGG W

$$I_x' = \left(\frac{K+1}{2}\right) L_a \sum_{y_i^2}^{i=\text{elbows ⊥ XZ, YZ}} + KL_a \sum_{y_i^2}^{i=\text{elbows ⊥ XY}} - \bar{y}\left[\left(\frac{K+1}{2}\right) L_a \sum_{y_i}^{i=\text{elbows ⊥ XZ, YZ}} + KL_a \sum_{y_i}^{i=\text{elbows ⊥ XY}}\right]$$

$$+ \alpha \sum_{y_i^2}^{i=\text{all elbows}} + \beta \sum_{y_i^2}^{i=\text{elbows ⊥ XY}} - \bar{y}\left[\alpha \sum_{y_i}^{i=\text{all elbows}} + \beta \sum_{y_i}^{i=\text{elbows ⊥ XY}}\right] \quad \ldots\ldots\ldots (11)$$

Where

$$\alpha = \left(\frac{K+1}{2}\right) L_a \quad \ldots\ldots (12)$$

$$\beta = \left(\frac{K-1}{2}\right) L_a \quad \ldots\ldots (13)$$

lated respectively in rows (16), (20), and (24). These final values are used to compute line inertias in rows (19), (23), and (27).

It is to be noted that the x, y, and z coordinates of the centroids of elbows are tabulated in "Lx," "Ly," and "Lz" columns in the "elbows" section of Table 1, i.e., L = 1 for all elbows.

The flexibility factor "K," the characteristic factor "h" and the effective length "L_a" of a mitre bend with a 45-deg center-line are:

$$K = \frac{1.52}{h^{5/6}} = \frac{1.52\sqrt[3]{h^{1/2}}}{h} \quad (K>1) \quad \ldots (14)$$

$$h = \frac{1+\cot\theta}{2}\left(\frac{t}{r}\right) \quad \ldots\ldots\ldots (15)$$

$$L_a = \frac{\pi R}{2} \quad \ldots\ldots\ldots (16)$$

where R for the mitre bend is defined as:

$$R = \frac{r(1+\cot\theta)}{2} \quad \ldots\ldots (17)$$

The above formulae can be applied in Equation 7 and Table 1 for the calculation of line inertias for a system containing mitre bends.

Nomenclature

L = Length of each piping branch (ft).
x, y, z = coordinates of the centroid of each piping branch or elbow with respect to the original arbitrarily chosen X, Y, and Z axes (ft).
$\bar{x}, \bar{y}, \bar{z}$ = coordinates of the centroid of piping system with respect to the original arbitrarily chosen X, Y and Z axes (ft).
I_x, I_y, I_z = moments of inertia of the system about its centroidal axes (ft⁴).
I_{xy}, I_{xz}, I_{yz} = products of inertia of the system about its centroidal axes (ft⁴).
I_1 = centroidal moment of inertia of branches parallel to Z-axis (ft⁴).
I_2 = centroidal moment of inertia of branches parallel to Y-axis (ft⁴).
I_3 = centroidal moment of inertia of branches parallel to X-axis (ft⁴), (I_1, I_2, and I_3 are 12 times the true values).
I_{ox}, I_{oy}, I_{oz} = sums of centroidal moments of inertia of elbows about their own respective neutral axes (ft⁴).
m = number of elbows in planes parallel to the axis of I_o.
n = number of elbows in planes perpendicular to the axis of I_o.
$I_{oxy}, I_{oxz}, I_{oyz}$ = sums of centroidal products of inertia of elbows parallel to the plane of inertia (ft⁴).
$\Delta_x, \Delta_y, \Delta_z$ = total thermal expansion of the system in the X, Y, and Z directions respectively (in.).
E_h = modulus of elasticity of the piping material at operating temperature or in the hot condition (psi).
E_c = modulus of elasticity at installation temperature or in the cold condition (psi).
I = moment of inertia of the cross-sectional metal area of the pipe (in.⁴).
S = section modulus of pipe (in.³).
D = outside diameter of pipe (in.).
t = thickness of pipe wall (in.).
r = mean radius of pipe (in.).
T = temperature (F).
e = thermal expansion in 100 ft of pipe due to a rise from installation temperature to operating temperature (in. per 100 ft).
R = radius of curvature of elbow or quarter bend (ft).
X, Y, Z = forces due to expansion (lb).
M_{xy}, M_{xz}, M_{yz} = bending moments due to X, Y and Z forces in XY, XZ, and YZ planes. (One of these moments is actually a torque) (ft-lb).
X', Y', Z' = relative force values.
$M'_{xy}, M'_{xz}, M'_{yz}$ = relative moment values in XY, XZ, and YZ planes.
M'_d, M_d = relative and absolute values of combined bending moments at point "d" of the system (ft lb).
T'_d, T_d = relative and absolute values of torque at point "d" (ft lb).
h = characteristic factor.
K = flexibility factor.
L_a = actual length of elbow or quarter bend, or effective length of mitre-bend (ft).
i = stress intensification factor.
α = transverse virtual length (ft).
β = differential virtual length (ft).
θ = one-half angle between adjacent mitre axes (deg).
c = cold spring factor.
X_h, X_c = values of X force in hot and cold conditions (lb).
s_b = blending stress (psi).
s_t = corresponding torsional stress (psi).
s_e = expansion stress at any point of the system; maximum expansion stress of the system, i.e., controlling stress range (psi).
s_a = allowable stress range (psi).
f = stress range reduction factor (f = 1 for 7000 or less temperature cycles over expected life of piping).
(1) to (27) = numerals each representing one row of figures.
A, B, C = symbols each representing one numerical value.
(a) = symbol representing three values A, B, and C.
(b), (c) = symbols each representing three values.
N = total number of elbows in a system.
N_{xy} = number of elbows parallel to XY plane.

Part 2 will be in the June issue of *The Refining Engineer*.

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TECHNICAL PAPERS HIGHLIGHT WPRA'S 46th ANNUAL MEETING

AN OUTSTANDING PROGRAM of technical papers, sound advice on current industry problems and good lessons in human values was presented at the Western Petroleum Refiners Association annual meeting, in San Antonio, Texas, March 24-26. A total of 12 technical papers were presented to the asphalt symposium, a fuel products session and two meetings on processing.*

Adequacy of asphalt producing capacity was questioned in a paper presented before the asphalt symposium by S. W. Downer, III, editor of *The Refining Engineer*. "There will be some problems in meeting the increased demands resulting from the Federal Interstate and Defense highway construction program. Tankage will have to be built and juggled around. Increased capacity may be desirable in certain areas (the Deep South Midwestern States) to meet expected shortages and/or to reduce predicted high seasonal storage requirements. Crude oils may have to be changed around, along with yields — mainly backing asphalt out of residual fuel. And, shipping and blending facilities may not be consistent with the desire to provide prompt, efficient customer service," he declared. (This paper will be in the next issue of *The Refining Engineer*.)

Thomas F. McGarey of Cities Service Oil Company told the symposium that "we have nothing to be ashamed of when we espouse its (asphalt's) usage. A superior product at a manifest saving of billions of dollars to the taxpayer—what better sales presentation was given to any industry?

"We, in the asphalt marketing phase of the petroleum industry, would warmly welcome those who are not now supporting The Asphalt Institute," McGarey said. He pointed out that while the vast percentage of asphalt refiners are members, that there are some outstanding exceptions.

McGarey was joined in telling of the many advantages of asphalt paving by Dr. Jesse E. Buchanan, president of The Asphalt Institute. One danger of the current method of Federal aid is, he believes, that some states would let cost considerations "go by the board" since the Federal government would be picking up 90 percent of the tab for the interstate and defense highway system. He pointed out that the New Jersey Turnpike saved $46,000 per mile by using asphalt paving rather than other types. "The oil industry, The Asphalt Institute and the public all have a vital interest in the successful completion of the road program," Buchanan emphasized.

Design of today's automobiles was scored by K. G. Mackenzie, president of the Chicago firm that bears his name. Speaking at a session sponsored by the Motor Fuels and Diesel Fuels Committees, Mackenzie stated that "the American automobile as at present designed is a most inefficient mechanism for transportation." He claims that many of the Detroit designs cause serious problems in servicing, safety, economy of operation, underhood temperatures and meeting octane requirements (chemically rather than mechanically). Mackenzie challenged the petroleum and automobile industries to recognize these common problems along with others on fuel volatility and crankcase draining frequency, calling for inter-industry cooperation to be raised to the highest level.

Referring particularly to specifications and rating of lubrication oils, William S. James called for use of two "languages," one in customer terms and the other in engineering terms to keep in step with advancing technology without disturbing the customer and the service station attendant. An example of such confusion, he declared, is the "multi-vis" crankcase oils. Multiple-valued technical terms should be clarified and non-technical interpretations provided to the public.

Work recently done in DuPont's Petroleum Laboratory on correlation of laboratory and road ratings of motor fuels was discussed by D. I. Pastell. He said that the Modified Uniontown octane numbers are the best indication of customer acceptance, giving this overall, average correlation with lab ratings for 1958 cars: Road Rating = 0.834(0.62 R.O.N. + 0.38 M.O.N.) + 17.1. Pastell also showed how operating variables in engines can effect fuel requirements and how lab ratings of individual blending stocks correlate with road ratings.

A set of performance parameters developed by Phillips Petroleum Company rating motor fuel quality from the standpoints of engine starting, warm-up, acceleration and vapor lock control were presented by T. W. Legatski. The paper, co-authored by O. C. Bridgeman and E. W. Aldrich, also with Phillips, pointed out that there is a marked lack of uniformity in performance quality at different seasons throughout the country, even after correcting for differences in ambient temperature. It was concluded that lack of uniformity is caused by inadequate technical understanding of ambient temperature effects and lack of required volumes of suitable blending stocks at all seasons of the year.

Processing requirements and costs for making motor fuels — present and future — were provided in a paper prepared by W. J. Service, R. E. Payne and W. E. Askey, all of The Pace Company, Houston, Texas. "A typical Gulf Coast refiner can produce motor gasoline with predicted quality requirements (104.5 and 97.5 R.O.N. for premium and regular, respectively) through 1963, using presently available commercial processes," they said. Moving from a base-case 50,000 bbl per day refinery, they presented capital and operating cost increases associated with attaining increasing octane quality requirements.

A continuous flash point instrument and an instrument for measuring end point were described in a paper "Instruments for Heater Oil Production," by S. F. Kapff and J. C. Rhodes, with Standard Oil Company (Indiana). Both are used to control heating oil sidestreams, are especially valuable when production is to be maximized. Installed at the operating unit, the flash point unit reads out every three minutes while the batch end point measurement requires about 18 minutes. Only time required for the operator on the latter instrument is the few seconds used in pouring in a sample and pressing a starter button.

Universal Oil Products spokesman Henry Grote introduced to the processing session two new processes — Alkar and Butamer. (Both are discussed in further detail on page A-11.) The Alkar process provides for catalytically reacting ethylene in deethanizer tail gas from catalytic cracking with benzene to form monoalkyl benzenes for use in petrochemicals manufacture while the Butamer process uses a platinum-containing catalyst for isomerization of normal butanes to iso-butanes. ★ ★ ★

*For complete program, see *The Refining Engineer*, March 1958, page C-56. Copies of papers are available in limited quantities from the WPRA, 1428 Hunt Building, Tulsa, Oklahoma.

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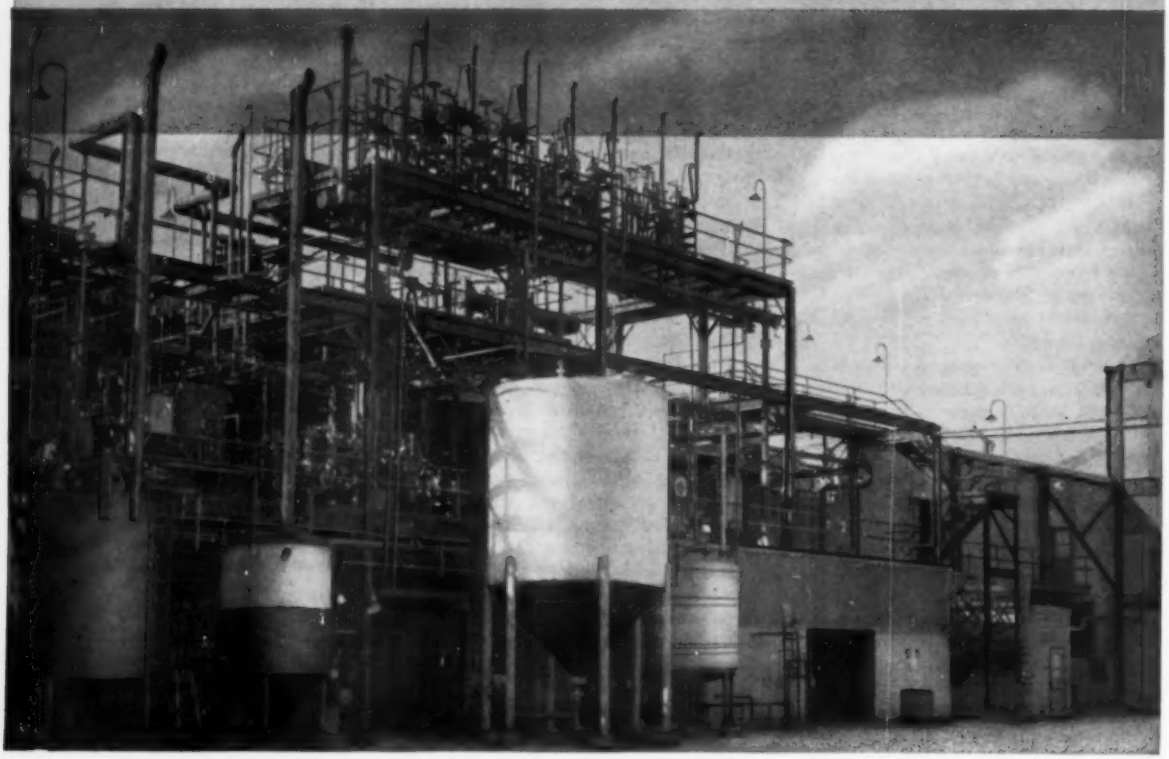

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Refining Personals

▸ **Douglas P. Bailey** has been named manager of the purchasing department of The Texas Company. He was previously manager of the operations division of the company's refining department.

▸ **Dr. Roger W. Richardson** has been appointed manager of the office of refinery liaison in Esso Research and Engineering Company. He had been associate manager of the unit. Esso Research is the central scientific affiliate of Standard Oil Company (New Jersey).

Three scientists and two engineers of Esso Research and Engineering were named associates, a technical position awarded to men of outstanding talents in research or engineering. Three of the men have been named research associates. They are **Herbert H. Vickers, Oliver G. Lewis,** and **William G. Dukek Jr.** The two recently-named engineering associates are **Moss F. Sheely** and **Earl M. Hawkins.**

▸ **Dr. Raymond Wynkoop** has joined Sun Oil Company's research and development division as assistant director — petrochemicals. During the past two years Dr. Wynkoop had been assistant to the president of the Houdry Process Corporation as well as manager of sales for Catalytic Construction Company.

▸ **William M. Harp** has been promoted to technical associate in technical service division at Humble Oil & Refining Company's Baytown, Texas, refinery.

▸ **P. J. Merkus,** manager of Shell Oil Company's Wilmington, California, refinery, has been named manager of the firm's Wood River, Illinois, refinery. Merkus succeeds **H. D. Dale,** who is retiring. **G. C. Montgomery,** superintendent of the Wilmington refinery, will become manager there. **J. B. St. Clair,** assistant superintendent of the Martinez, California, refinery, succeeds Montgomery. **E. A. Ballman** succeeds St. Clair, formerly serving as assistant manager of the Shellburn refinery of Shell Oil Company of Canada, Limited.

▸ **J. C. Stirton,** Arabian American Oil Company's vice president in charge of engineering and construction, has retired. **L. M. Snyder,** previously Aramco's vice president in charge of operations, has assumed the position of vice president in charge of engineering, construction and local sales. **W. R. Cooper** has become general manager of engineering and construction.

▸ **Harold R. Porter** has been named assistant manager, product engineering department, Standard Oil Company of California. Porter moves up from the position of senior product engineer. He succeeds **Benjamin M. Berry,** who has retired.

▸ **William E. McTurk** has been appointed assistant director of the public relations division of Esso Research and Engineering Company.

▸ Sohio Petroleum Company has announced the promotion of **James E. Owens** to the position of division gas superintendent for the Gulf Coast division at Houston, Texas. He has been serving as a staff assistant to the division manager.

▸ **Alvah E. Esser** has retired from Socony Mobil Oil Company, Inc., where he has been manager of the engineering department since 1938.

▸ **Dr. Alex Lewis Jr.** has been promoted to manager, petrochemicals department. He previously was in charge of chemical marketing for the petrochemicals department and will succeed **L. O. Crockett** who was recently elected president of Goodrich-Gulf Chemicals, Inc. in Cleveland. Dr. Lewis' headquarters will continue to be in the Gulf Building, Pittsburgh.

▸ **George F. Hornaday** has been named manager of the research and development division of Houdry Process Corporation. Hornaday has been assistant manager of the division since December 1956.

▸ **C. W. Butler** has been named director of the automotive engineering division, Gulf Research & Development Company. He succeeds **J. E. Taylor,** who has been appointed director of automotive research and assigned to the company's newly opened offices in Detroit.

▸ **Paul J. La Marche** has been made director of production for U. S. Industrial Chemicals Company, division of National Distillers and Chemical Corporation.

▸ **P. Craig Livesay,** manager of the Standard Oil Company (Indiana) refinery at Neodesha, Kansas, has been named manager of the Sugar Creek, Missouri, refinery to succeed **Harold R. Boehmer** who has retired. **Harry G. Schnetzler,** assistant refinery manager at Neodesha, will succeed Livesay.

▸ **Edwin H. Krieg,** vice president and consulting engineer of Stone & Webster Engineering Corporation has been elected a director.

▸ **Alfred B. Vought** has retired as refining coordinator for the Standard-Vacuum Oil Company at its White Plains, New York, headquarters and has been succeeded by **William A. Williams.**

▸ The appointment of four supervisors at Shell Development Company's Emeryville (California) Research Center, has been announced. **R. P. Bell** will supervise the computation laboratory and **P. Stillson** the operations research and statistics group in the applied mathematics department. **J. F. Fidiam** will direct the activities of the design engineering and manufacturing section of the instrumentation department. **D. B. Caples,** who has been concerned with the installation and maintenance of Shell's ElectroData computer, will be responsible for the work of the computer maintenance group in the mechanical and electrical engineering department.

▸ **H. Harold Bible,** vice president and assistant general manager of Monsanto Chemical Company's Lion Oil Division, has been elected a Monsanto vice president and general manager of the Lion Oil Division.

John L. Gillis, vice president and director of Monsanto Chemical, has been elected to the company's executive committee. **T. M. Martin,** vice president and director, has also been elected to the company's executive committee. **Dr. David T. Mowry** has been appointed director of development for Monsanto's research and engineering division after serving as assistant director of that department since 1957. **Irving C. Smith,** chairman of Monsanto's budget committee, has been elected vice president after serving as controller and director of the company's accounting department since 1955.

▸ **Henry Flynn,** general superintendent of The Texas Company's largest refinery, at Port Arthur, Texas, has been named manager. He succeeds **F. L. Wallace,** who has retired. **E. W. McNealy,** assistant general superintendent, will succeed Flynn as general superintendent.

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For thirty-five years, Carrier Centrifugal Compressors have been serving leaders of industry in refineries and chemical plants throughout the world. In that time, they have earned an outstanding reputation for dependable, efficient performance. Now this same high standard of performance is available in an expanded Carrier line of multi-stage air and gas compressors with nine frame sizes from 1000 to 150,000 cfm. Each frame size is offered in 1 to 9 stages, depending on frame size, to meet your needs.

Many factors, of course, must be considered in selecting the right compressor for a job. The experience of the manufacturer is, of course, the most important. Carrier has built more multi-stage centrifugals than any other maker. Craftsmanship is important, too. Carrier has the most modern facilities for the production of centrifugal compressors. Finally, there is application skill. Carrier has handled more kinds of gases than any other manufacturer.

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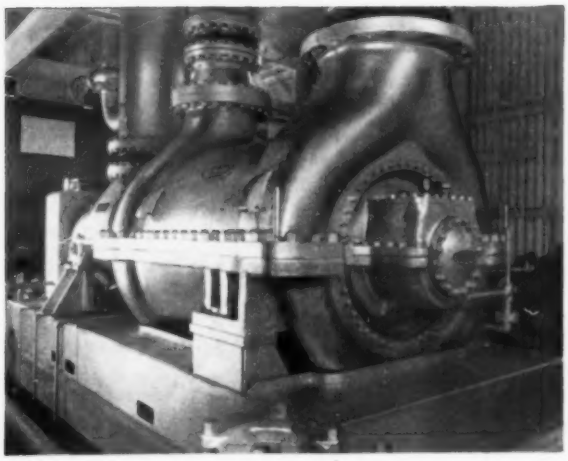
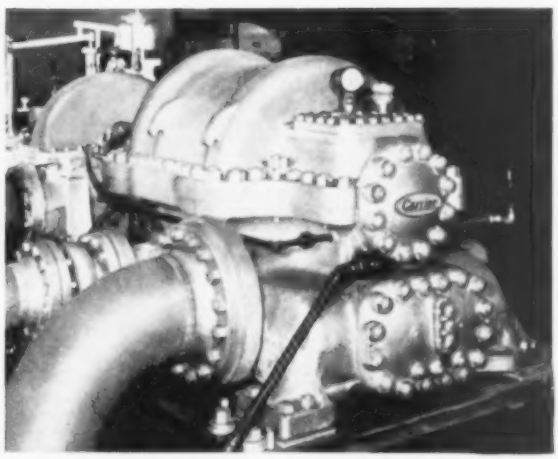


For volume flow up to 150,000 cfm, Carrier now offers an expanded line of multi-stage Centrifugal Compressors for air and gas in nine frame sizes.



For volume flow starting at 1000 cfm, Carrier Centrifugal Compressors are the dependable, efficient answer. This unit is the smallest in the line.

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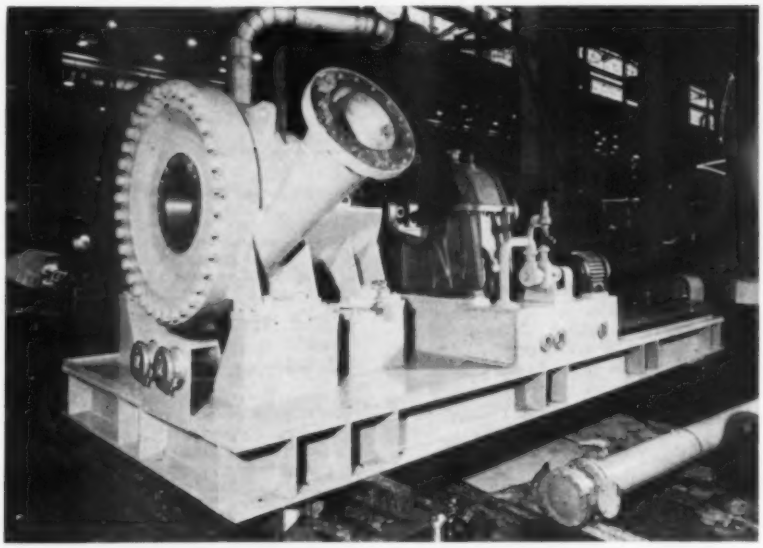

This newly-developed single stage centrifugal compressor can operate up to a 500 psig working pressure. Unit is designed to boost pressure in existing gas or air systems or for recirculating high pressure gas for cooling and processing. *Allis-Chalmers Manufacturing Company.*

Circle number (41) on reply card.

New Data Processing System

New data handling unit, Model 123, scans up to 100 points at rate of 1 per sec. There are 25 combinations of scaling and zero-offset, high or low alarm limits and square root extraction for flow measurement. Unit has sealed stepping switches, uses transistors throughout. *Beckman/Systems.*

Circle number (42) on reply card.

Nickel-Base Hard-Facing Powder

New nickel-base hard-facing powder containing tungsten carbide and chromium borides is available. It is particularly applicable to cylindrical moving parts, but not recommended for elevated temperatures where high oxidation resistance is a prime consideration. *Wall Colmonoy Corporation.*

Circle number (43) on reply card.

Enlarged Line of Indicating Flow Meters

Expanded line of indicating liquid flow meters for pressures up to 2000 psig has scale ranges from 0-6 gph to 0-6000 gph. Gas flow models have scale ranges from 0-0.5 cfm up to 2400-60,000 cfh. Movable vane principle is used. *Seico Instrument Division, Eclipse Fuel Engineering Co.*

Circle number (44) on reply card.

New Chemical Cleaning Service

Service is for chemical cleaning of refinery and other plant equipment, in place, using equipment mounted on flatbed trucks. Now available in Gulf Coast and West Coast areas. Service also includes steam and blast cleaning. *Kelite Corporation.*

Circle number (45) on reply card.

Corrosion-Resistant Plastic Packing

Non-gelling, putty-like packing material that is moldable under pressure to stuffing box contour is announced. The self-lubricating material is made of finely divided Teflon and fractions of polychlorotrifluoroethylene oil. *Halocarbon Products Corporation.*

Circle number (46) on reply card.

Range of Pressure Gage Tester Extended

A new piston-cylinder arrangement available for Type 6-201 Primary Pressure Standard extends range of the instrument to 500 psi, with existing weight sets. Additional information in Bulletin 1581. *Consolidated Electrodynamics Corporation.*

Circle number (47) on reply card.

New Liquid Level Sensor

Designed to give an actuating signal to control or indicate a predetermined level, Betatrol unit employs beta radiation. Up to 200 ft of cable can be connected to the amplifier, applications include water, acids, alkalies, oils and viscous liquids. *Aeronautical and Instrument Division, Robertshaw-Fulton Company.*

Circle number (48) on reply card.

Titanium Fittings Available

Complete line of titanium weld fittings and flanges will be made available to industry, suited to all sizes and schedules of titanium piping available. Corrosion resistance and weight savings are major savings claimed. *Tube Turns, a division of National Cylinder Gas Co.*

Circle number (49) on reply card.

Leakproof Seal for Connecting Dissimilar Metals

New tubing joint is designed to operate from −300 to 1800 F. The joint is available in almost all desired sizes, is all-metal, including the gasket. *Marman Division, Aeroquip Corporation.*

Circle number (50) on reply card.

Flow, Level Transmitter

Designed for handling corrosive liquids, liquids that would gel when not in motion, suspensions and slurries, the Taylor 205T differential pressure transmitter is described in Bulletin 98281. It can be used for flow, liquid level and differential pressure applications. *Taylor Instrument Companies.*

Circle number (51) on reply card.

Aluminum Duplex Pipe

This new Reynolds tubular product is extruded in four sizes ranging from 1 to 4 in., in 30 ft lengths. Non-standard lengths from 3 to 40 ft can be provided. Uses and methods of joining are detailed in available literature. *Reynolds Metals Company.*

Circle number (52) on reply card.

New Equipment

New Unit for Tube Rolling

New unit is a self-contained torque control unit for expanding tubes in tube sheets, is adaptable to available air or electric tube rolling motors. Dial setting is used to increase or decrease torque values. *The Gustav Wiedeke Co.*

Circle number (53) on reply card.

Electric Cable Vulcanizers

New line of electrically-operated cable vulcanizers is particularly adaptable to maintenance of portable electric cables used in process plants. Full details are available. *Electrical Products Division, Joy Manufacturing Company.*

Circle number (54) on reply card.

New Apparatus Checks Heat Transfer Rates

Newly-developed heat transfer testing equipment has shown bond-resistance to be neglible for L/C and other bare and finned bi-metal tubes. Heat transfer data and literature are available. *Wolverine Tube Division of Calumet & Hecla, Inc.*

Circle number (55) on reply card.

Pyroceram Heat Exchange Tubing

Commercial production of Pyroceram tubing and plates for high temperature heat exchangers is underway. A nucleated form of glass, material is claimed to be 3 times as strong as ordinary glass, will withstand extreme thermal shock. *Corning Glass Works.*

Circle number (56) on reply card.

Subminiature Rotary Selector Switch

New series of these assemblies, especially suited for use on electronic control panels where space is limited, has been announced. Data sheet 86b gives full details. *Micro Switch, division of Minneapolis-Honeywell Regulator Company.*

Circle number (57) on reply card.

Stall-Proof Additives for Gasolines

Gulf Agent 178, a surface active type anti-stall additive is being marketed through Gulf's Petrochemicals Department. Average dosage is 18 lb per thousand bbl of gasoline. *Gulf Oil Corporation, Petrochemical Department.*

Circle number (58) on reply card.

High Pressure Hydrometer for LPG

New high pressure hydrometer jar permits measuring specific gravity of LP-Gases at working pressures up to 1000 psi. Earlier model handles up to 200 psi. *Koehler Instrument Co., Inc.*

Circle number (59) on reply card.

Tank Breather Valve

New 3-in. diaphragm-type breather valve has been introduced to extend product line. Complete specifications, details, flow diagram and other engineering data are available. *Shand and Jurs Company.*

Circle number (60) on reply card.

Dissolved Oxygen Analyzer

New instrument automatically and continuously measures oxygen content in high purity boiler feed water to traces as low as 1 part per billion. Multiflow sampling system available so that up to 4 streams can be handled. *Beckman/Process Instruments Division.*

Circle number (61) on reply card.

New Power Capacitor Ratings Announced

Two new, higher ratings for power capacitors used with pump motors are available, designed to meet demand for larger blocks of kilovars resulting from trend to larger motors. *General Electric Company.*

Circle number (62) on reply card.

New Pressured, Dry Extinguishers

Two new models of fire extinguishers use dry powder and pressure squeeze-lever construction. Recommended for electrical fires and flammable liquids, built-in gage is provided, charge pressure is 150 psi. *Fyr-Fyter Division*

Circle number (63) on reply card.

White Ion Exchange Resin

Increased stability and strength are claimed for a new white, high capacity resin for both industrial and home use. Attrition losses are claimed to be minimized due to higher bead strength. *The Dow Chemical Company.*

Circle number (64) on reply card.

Self-Lubricating Pump Components

New line of bearings, seals and vanes are said to be self-lubricating, non-contaminating, non-warping and corrosion-resistant. They are especially suggested for seal mechanisms or inaccessible locations. *Mechanical Carbon Division, Morganite Incorporated.*

Circle number (65) on reply card.

Gate-Type Vacuum Valves

New series has full-opening design with straight-through flow, will seal tight against atmospheric pressure in either direction. Pneumatic, handwheel and toggle-lever operation are offered. *Vacuum Equipment Division, F. J. Stokes Corporation.*

Circle number (66) on reply card.

Redesigned Synchronous Generators

Units are redesigned in single bearing units for internal combustion engines, close-coupled to standard SAE flanges, or 2 bearing units for belt drive, or direct connection. Sizes range from 37.5 to 375 KVA. *Allis-Chalmers Mfg. Co.*

Circle number (67) on reply card.

New Research Chromatograph

New research model Kromo-Tog for gas and vapor chromatography has been introduced. It is designed to handle materials boiling up to 475 C and higher. *Burrell Corporation.*

Circle number (68) on reply card.

NEW LITERATURE

Nonionic Surfactants

A 40-page technical bulletin describes adducts of nonyphenol or tridecyl alcohol with ethylene oxide. Analytical procedures, properties and uses are presented. *Jefferson Chemical Company, Inc.*

Circle number (69) on reply card.

Process Vapor Fractometer

Design, operation and specifications of gas chromatographer for process stream analysis is presented in a 12-page pamphlet. *Perkin-Elmer Corporation.*

Circle number (70) on reply card.

Corrosion-Proof PVC Linings

Manual LC-58 covers 3 types of PVC linings, includes table to aid in selection according to type of material to be handled and temperature. *Kaykor Industries, Inc.*

Circle number (71) on reply card.

Polyethylene Resins

Tenite Polyethylene is the title of a new 36-page booklet on applications for a variety of functional and attractive plastic products, including insulation and pipe. *Eastman Chemical Products, Inc.*

Circle number (72) on reply card.

New Valve Catalog

Eight-page publication includes specifications for metering, gate, butterfly and check valves of lightweight design. *Fabri-Valve Company of America.*

Circle number (73) on reply card.

150 WSP Bronze Valves

Service ratings, dimensional drawings, design and selection of bronze globe, angle and check valves are described in new brochure. *Walworth Company.*

Circle number (74) on reply card.

Absorption Cell Catalog

Absorption cells and other sample handling accessories for spectrophotometers are described and illustrated in Bulletin 729. *Beckman/Scientific Instruments Division.*

Circle number (75) on reply card.

Conversion Chart

Engineering data conversion chart for mounting on your office wall available at no cost. Many important conversion factors are given. *Precision Equipment Company.*

Circle number (76) on reply card.

Mechanical Considerations In Pump Design

Eight-page booklet EM-79 covers basic types of process pumps and the load effects on each. Cause, effect and cure of damaging radial thrust forces on impellers, bearings and other parts are discussed along with design techniques and precautions. *Peerless Pump Division.*

Circle number (77) on reply card.

Order These *Refining Engineer* Reprints Now!

How to Design Multicomponent Fractionators by R. L. Hengstebeck, Standard Oil Co. (Ind.)	Single copies 50¢, additional copies 25¢ each. 8 pages.
Symposium—Bright New Horizons for Asphalt a special report from the March issue	Single copies 50¢ each, 40¢ in lots of 25 or more. 20 pages.
Correlating Asphalt Capacity and Demand 1960-67 by S. W. Downer III, preprinted from June, 1958 issue.	Single copies 50¢ each, additional copies 25¢ each. 6 pages.
How to Design Effective, Low Cost Tank Mixer by R. B. Meny and R. B. Velykis	Single copies 25¢ each. 4 pages.
Selection of Furnace Tubes for Refinery and Petrochemical Service, by Thomas M. Krebs	Free (send 10¢ per copy for handling charge). 10 pages.
How to Write Better Technical Articles	Free. 4 pages.

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Box 1589, Dallas 21, Texas.

Crab Tractor

Brochure describes 4-wheel-drive, 4-wheel steering tractor on which blades, backhoes, buckets or fork lift can be mounted. *Nabco Industries, Inc., Federal Motor Truck Company.*

Circle number (78) on reply card.

Polargraphic Analysis

Data sheet E-94(3) gives concise information about the Electro-Chemograph[R] equipment for polarographic analysis in chemical laboratories. *Leeds and Northrup Company.*

Circle number (79) on reply card.

Clad Metals for Vessel Fabrication

New 32-page brochure "Hortonclad" describes manufacture and uses of composite metal made by bonding an alloy of special metal with less expensive backing plate. Variety of available cladding and backing metals also presented. *Chicago Bridge & Iron Company.*

Circle number (80) on reply card.

Microsampler for Chromatographs

Syringe-type device is designed for introducing very small samples into inlet system of gas chromatographs; 0.005 to 0.05 cc. *Beckman/Scientific Instruments Division.*

Circle number (25) on reply card.

Fuel Oil Additive

DuPont FOA No. 2 is claimed to minimize formation of fuel oil sludge during normal storage periods. Data on performance and application available. *E. I. duPont de Nemours, Inc., Petroleum Chemicals Division.*

Circle number (26) on reply card.

Care of Glassed-Steel Reactors

Installation, operation and maintenance of glassed-steel reactors is detailed in new Bulletin 955. Discussion includes gasketing for corrosive conditions, cleaning methods, and thermal shock. *The Pfaudler Company.*

Circle number (27) on reply card.

Centrifugal Compressor Data

New 64-page catalog provides discussion on types, specifications, design and applications of centrifugal compressors. Engineering data are included. Bulletin 150. *Clark Bros. Company.*

Circle number (28) on reply card.

Diaphragm Feeder

Bulletin No. 1913-2 describes redesigned wall-mounted feeder for additives and small quantities of chemicals from .08 to 8.0 gal per day, water or air-operated. *Proportioneers, Inc.*

Circle number (29) on reply card.

Small Valves Described

Line of small valves for use in instrumentation, chemical and petroleum processing, etc., described and specifications given in Catalog MV-957 "Fluid Control Products." *Hoke, Inc.*

Circle number (30) on reply card.

Pressure Piping Systems Design

Bulletin FB77 summarizes and correlates various specifications of ASA Pressure Piping and ASME Boiler and Pressure Vessel and Unfired Pressure Vessel Codes. Extensive tables enable simple mathematical procedure for determining piping and system specifications. *Babcock & Wilcox, Tubular Products Division.*

Circle number (31) on reply card.

Quoth Sir Galva-Knight:

"NEVER GIVE RUST A START!"

Give it even a tiny chink, and rust can quickly ravage steel structures or equipment. Only *hot-dip galvanizing* can seal up every nook and cranny, inside and out, with an armor-tough coating of zinc, actually alloyed with the steel. To stop rust before it starts, specify hot-dip galvanizing by the Nowery J. Smith Company, the South's largest commercial galvanizers.

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RADIATOR SPECIALTY CO.
Charlotte, North Carolina

SOLDER SEAL

Engineers, Superintendents, Managers:

See page C-42-a in this issue

for sample of important new feature

THE REFINING ENGINEER'S *Process* NOTEBOOK

A summary of the important data you need to know about today's refining and petrochemical processes.

- process flow diagram
- key operating conditions
- description of process
- product and yield data
- investment information
- full data for operating cost "buildup"

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Walworth High Pressure Lubricant Gun. This gun satisfactorily handles the stick form, full-bodied lubricants needed for proper lubrication and sealing of plug valves. Easy to operate: Two Jumbo Size Lubricant Sticks fill the barrel.

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PIPELINE DEVELOPMENTS ★ ★ ★

Roundup of Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Act Oils Toronto, Ontario, Canada	350		Line from Peace River area in British Columbia, thru Pine Pass to Prince George, westward to Bella Coola terminus on Pacific Coast
Afrique du Nord Development Societe	850	18	Hassi-Messaoud field, Algeria, to Mediterranean port
Alaska Yukon Pipe Lines, Inc.	254	—	Valdez to Tok Junction, Alaska
Alborz Oil Company	1000	38	Qum, Iran, to Alexandretta, Turkey
Argentine Government (YPF) Buenos Aires, Argentina	640	12	Campo Duran fields to Rosario
Atlantic-Cities-Service-Continental-Gulf-Phillips-Texas-Sinclair	Approx. 385	26	Midland, Texas, area to Houston
Bituminous Oil Pipeline, Ltd. Calgary, Alberta, Canada	250	—	McMurray to Edmonton, Canada
Bolivian Government (YPFB) La Paz, Bolivia	215	8, 10	Interior of Bolivia to Arica, Chile
Cape Pipe Line Company Philadelphia, Pennsylvania	200		Large diameter from Delaware Bay to Greater Philadelphia area refineries
Creole Petroleum Corp. Caracas, Venezuela	86	30	Temblador field to Caripito, Venezuela
Gillette Pipeline, Inc., and A. W. Hartwig, Inc.	102	—	Dead Horse Creek field to Casper, Wyoming
Great Northern Railway Co. St. Paul, Minnesota	600	12–20	Williston Basin to St. Paul-Duluth-Superior, Wisconsin-Minnesota area
Iraq Petroleum Co. London, England	Approx. 600		Kirkuk field to Iskenderun, Turkey
Jayhawk Pipe Line Corporation Wichita, Kansas	242	10, 12	Meade County, Kansas, to Valley Center
North-West Oil Pipelines Company	210		Wilhelmshaven, on the North Sea, to industrial Ruhr area of West Germany
Offshore Gathering Company Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Oil Field Pipe Line, Inc. and Panhandle Eastern Pipe Line Co. Kansas City, Missouri	200	8, 12	Elkhart to Ellinwood, Kansas
Royal Dutch Shell Group and Others The Hague, Netherlands	870	30	Marseille, France, to Rotterdam, Holland, and Antwerp, Belgium
Royal Pipe Lines, Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Shell Pipe Line Corporation Houston, Texas	100		Southwest Pass Terminal to Norco, Louisiana, Refinery
Southern Kansas Pipe Line Company	310	6, 10	Greenwood pool, near Colorado line, thru Liberal to Arkansas City, Kansas
Trans-Border Line Company	110		Skagway, Alaska, to Whitehorse, Yukon Territory
17 American, English, French and Dutch Companies	1500	38–40	Middle East producing areas to Mediterranean Coast in Turkey
Yacimientos Petroliferos Fiscales Buenos Aires, Argentina	375-434		Challaco, Neuquen Province, to Arroyo Parejas

PRODUCT LINES

Name of Company	Miles	Size	Location
American Pipe Line Co. New York, New York	1910	8–26	Beaumont, Texas, to Newark, New Jersey
Conn-Mass Pipe Line, Inc.	328	6, 8, 16	In Connecticut, Massachusetts, New Jersey
Hydrocarbons Pipelines, Ltd. Winnipeg, Manitoba, Canada	800	6–8	Edmonton, Alberta, to Fort William, Ontario
M.K.&T. and New York Central Railroads	2000	—	Houston-Kansas City-St. Louis-Indianapolis-Cleveland-Syracuse, New York, with branches to Chicago and Detroit
Mene Grande Oil Company Caracas, Venezuela	60	6	Anaco to Puerto La Cruz, Venezuela
Northwest Pipeline Corporation Salt Lake City, Utah	350	8–10	Four Corners to Salt Lake City, Utah
Service-Continental-Sinclair-Phillips	550		Salt Lake City, Utah, to Spokane, Washington
Underground Storage and Exploration, Inc. Upper Darby, Pennsylvania	393	6, 8, 12	Moundsville, West Virginia, to Newark, New Jersey, with laterals to Mauch Chunk, Marcus Hook, and Philadelphia
Union Oil Company of California Los Angeles, California	815		Shale oil plant, Rifle, Colorado, to Los Angeles area
Winnipeg & Central Gas Company Winnipeg, Manitoba, Canada	210	6	U.S. Canadian border to Winnipeg

GAS LINES

Name of Company	Miles	Size	Location
Andes Pipeline Corporation	500	12	Villamontes, Bolivia, to Antofogasta, Chile
Argentine Government (YPF) Buenos Aires, Argentina	815		Campo Duran fields to Buenos Aires
Arkansas Louisiana Gas Company Shreveport, Louisiana	300		Main and gathering lines Louisiana-Texas Gulf Coast
Coastal Transmission Corporation	574	22–26	McAllen, Texas, to Baton Rouge, Louisiana
Dallas, Texas	414	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company Colorado Springs, Colorado	917	4–34	New lines, loops, replacements in Texas, Colorado, Nebraska, New Mexico, Kansas, Oklahoma
Cuban Gas Transmission Company (Edwin Pauley) Los Angeles, California	1000		Mexico to Florida via Cuba
Eastern Shore Natural Gas Company Salisbury, Maryland	124	6, 8	Transmission line and facilities in Delaware and Maryland
Edison Securities Company Los Angeles, California	130		San Joaquin Valley to Los Angeles
El Paso Natural Gas Company El Paso, Texas	599	6–30	New lines and loops, New Mexico and Arizona
Gulf Interstate Gas Co.	352	30	Loops to lateral lines
Houston, Texas	54	24	
Houston Texas Gas & Oil Company Houston, Texas	942.6	12–30	Baton Rouge, Louisiana, to Miami, Florida Laterals to serve Florida distributors and industrial users
Iron Ranges Natural Gas Co.	120	6, 12	Mesabi Iron Range to northern Minnesota
	63	12	North Shore of Lake Superior
Kentucky Gas Transmission Corporation,	20.5	26	To parallel existing lines in Bracken County, Kentucky
Michigan Wisconsin Pipe Line Company Detroit, Michigan	638	4–24	Laterals and loops in Wisconsin, Michigan, Missouri, Illinois, Indiana
Midwestern Gas Transmission Company Houston, Texas	2067	3–24	Main line from U.S.-Canadian border near Emerson, Manitoba—Noyes, Minnesota, to Portland, Tennessee Laterals off main line to serve communities in Minnesota, North Dakota, and Wisconsin
Missouri Transportation Corp. Springfield, Missouri	280	16	Delaware County, Oklahoma, to St. Louis, Missouri
Mookl Chemical & Gas Corp. Tulsa, Oklahoma	169	16	Pottawatomie County to Delaware County, Oklahoma
Natural Gas Pipeline Company of America	416	36	Loop from Beatrice, Nebraska, to Joliet, Illinois
Chicago, Illinois	337	30	Loop from Fritch, Texas, to Beatrice, Nebraska
Niagara Mohawk Power Corp. Syracuse, New York	196	2–16	Central, eastern, and northern New York
North Carolina Natural Gas Corp. Houston, Texas	625	2–16	Intrastate line in North Carolina
Northern Natural Gas Company Omaha, Nebraska	1355	2–30	New lines and loops, Minnesota, Wisconsin, Alberta, Texas, Oklahoma, Kansas, Nebraska, Iowa
Northern Plains Natural Gas Company (subsidiary of Northern Natural Gas Company) Omaha, Nebraska	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Pacific Gas & Electric Company San Francisco, California	1300	36	Alberta, Canada, gas fields to Antioch, California
Petroleos Mexicanos Mexico City, Mexico	130	22	Reynosa to Monterrey
Piedmont Gas Co. Hickory, North Carolina	78	2–8	In Gaston, Lincoln, Catawba, Caldwell, and Burke counties, N. Carolina
Saskatchewan Power Corporation	90	16	Main line extension system from Hatton field to Success, Saskatchewan
Regina, Saskatchewan	75		Gathering system in Hatton field, western Saskatchewan
	40	12	Main line extension from Moose Jaw to Regina
	125	10	Service line extensions to Weyburn and Estevan
Southern California Gas Co. **Southern Counties Gas Co.** Los Angeles, California	83	34	From Coles Levee to Newhall
Southern Natural Gas Company	144	20, 24, 26	South Louisiana loops
Birmingham, Alabama	215	Var.	Supply lines Southern Louisiana.
Tennessee Gas Transmission Company	556	30	South of New Orleans to Portland, Tennessee
Houston, Texas	76	24	Coudersport, Pennsylvania, to Hamburg, New York
	163	30	Loop from Portland, Tennessee, and Winchester, Kentucky, to Lancaster and Morehead, Kentucky
	39	26	Loop from Catlettsburg, Kentucky, to Broad Run, West Virginia
	12	26	Loop south of Mercer, Pennsylvania
	50	26	Loop from Morehead, Kentucky, to Catlettsburg, Kentucky
	350		Portland, Tennessee, to Joliet, Illinois
Texas Eastern Penn-Jersey Corporation Shreveport, Louisiana	65	30	Loop from Delmont, Pennsylvania, to Lambertville, New Jersey
Trans-Canada Pipe Lines, Ltd.	492	30	New line from Kapuskasing, Ontario, to Sheridan, Ontario, Canada
Calgary, Alberta, Canada	48	24	New line from Winnipeg, Manitoba, to Emerson, Manitoba, Canada
Transcontinental Gas Pipe Line Corporation Houston, Texas	375	3–36	Main line loops, laterals, extensions to system
Trans-Western Pipe Line Company Los Angeles, California	775		Four Corners area to point in California
United Gas Pipe Line Company Shreveport, Louisiana	202	30	Loops from southeast Louisiana to Mobile, Alabama

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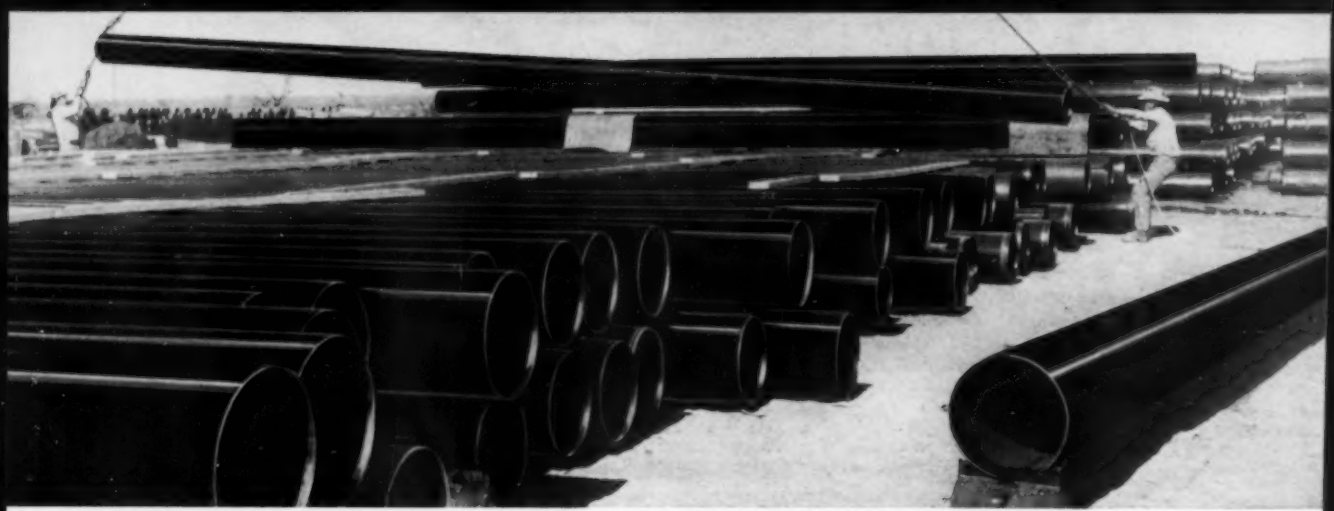
Now, lay coated pipe without special handling



ABOVE: 16-inch pipe being spray-coated for use in new Transcontinental Gas Pipe Line Corp. gas-gathering system near Tilden, Texas.

Save up to 20 per cent in laying costs on large-diameter pipelines. Spray—coat pipe with Copon Arocoat before installation. Then, haul it, stack it, bend it and lay it with little more care than you would use for bare pipe. Tough Copon Arocoat coatings will survive these operations without chipping or cracking, and Copon Arocoat can be applied to welds with an ordinary paint brush.

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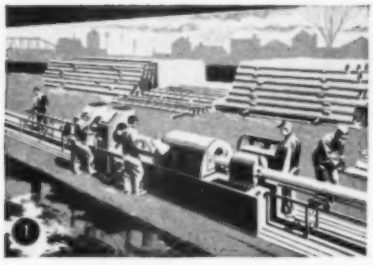

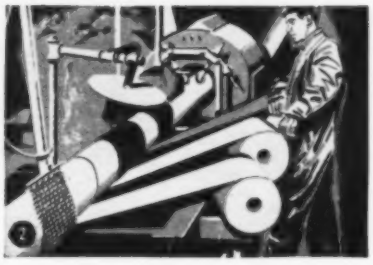

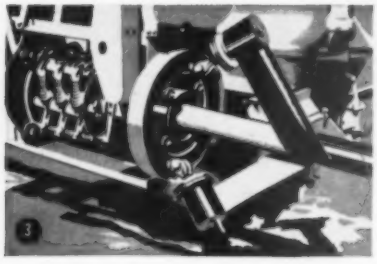

Varying circumstances, job conditions, and even budget limitations prohibit specifying one type of coating for every pipeline. That's why Dearborn offers you all three: asphalt coatings; wax-type coatings; polyethylene plastic tape. These superior coatings, together with the correct primers and wrappers, may be applied at the mill, railhead, by hand or Traveliner. Your local Dearborn representative can help you select the right coating combination for your specific job at lowest possible cost.

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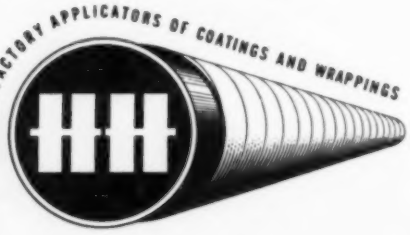

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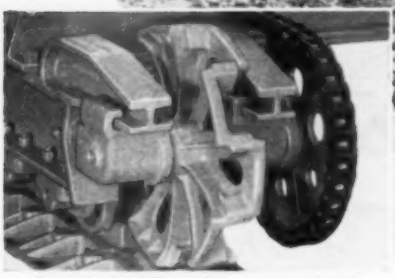
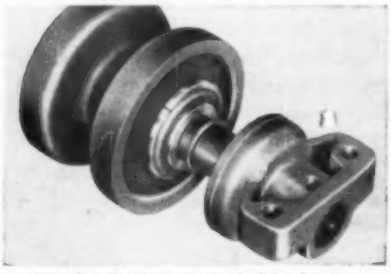
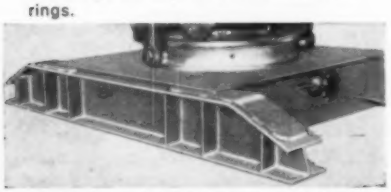


Crawler End Tumblers equipped with bronze seal rings.



Crawler Rollers protected by bronze seal rings and by neoprene rubber O-rings.



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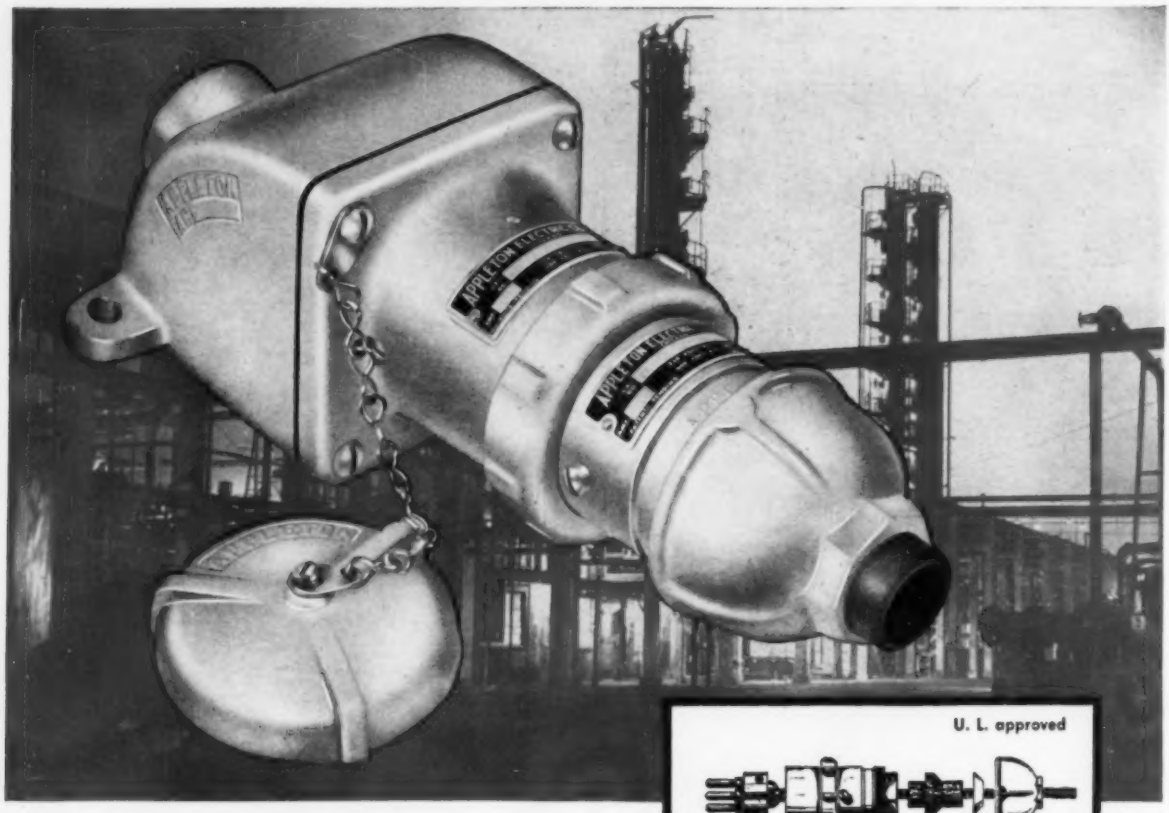

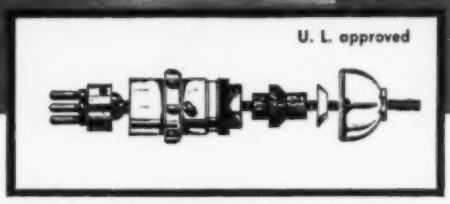

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Complete terminal units, equipped with solderless connectors enable connections to be made quickly with a minimum of effort. APPLETON "AE" Series Receptacle Housings are available in four styles to meet your specific requirements: Lift Cover Housing . . . Plain Housing . . . Threaded Housing . . . and Cap Housing. The Lift Cover Housing has a rubber-gasketed cover mounted on a self-aligning plate to form a dust-resisting enclosure which excludes chips, shavings, etc. Plugs are available with and without Clamping Ring. For utmost versatility and service life, APPLETON "AE" Series Plugs, Receptacles and Receptacle Housings offer an outstanding combination of quality features and economy of purchase.

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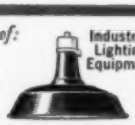
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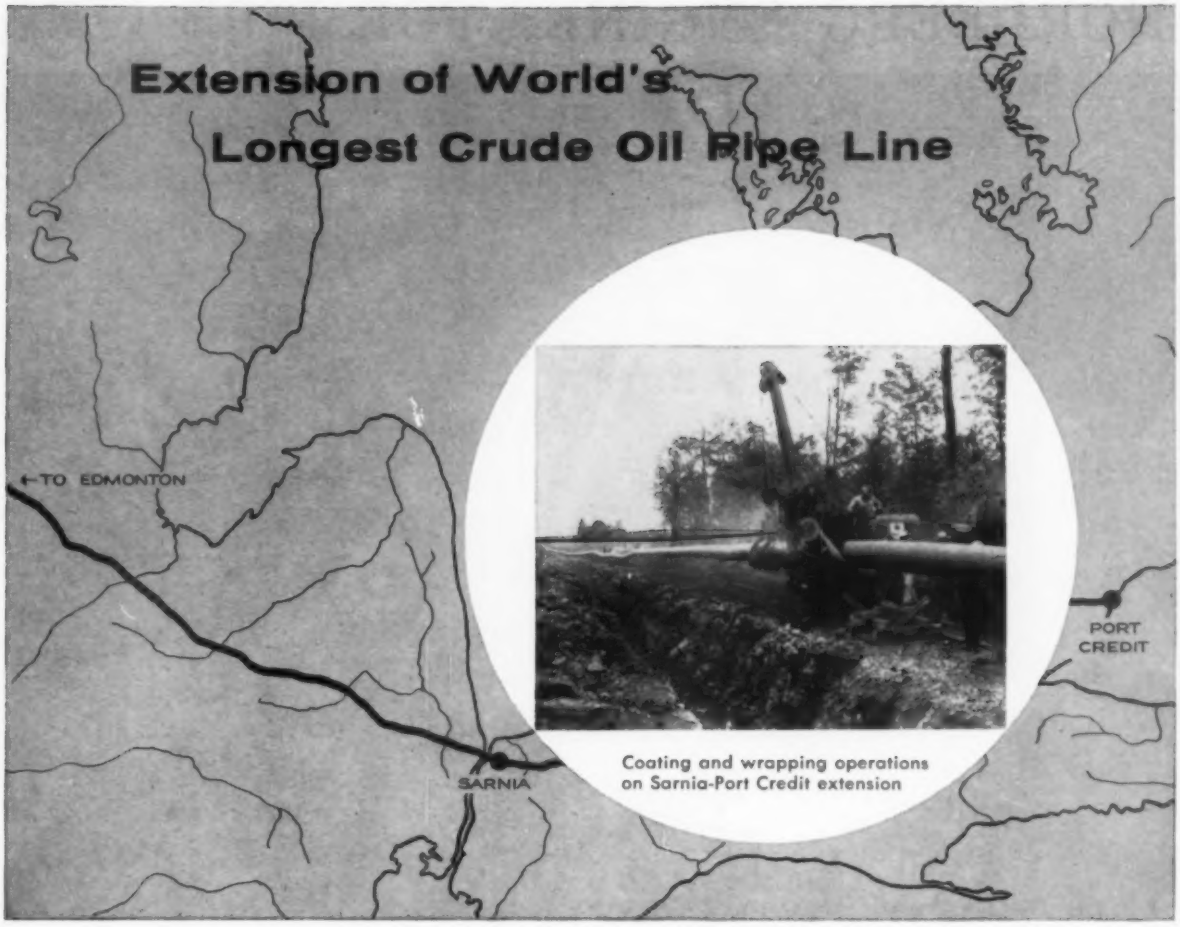

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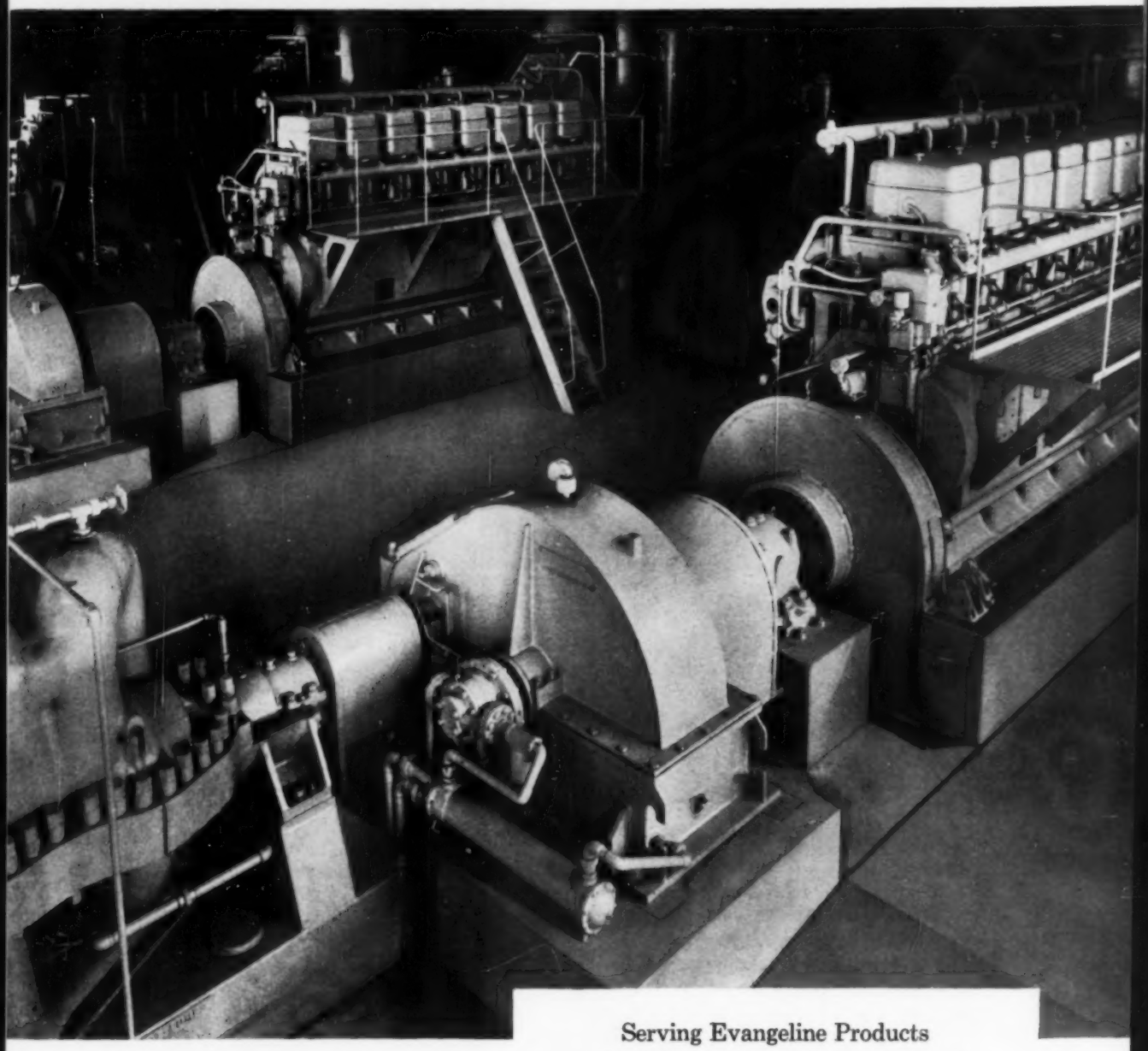

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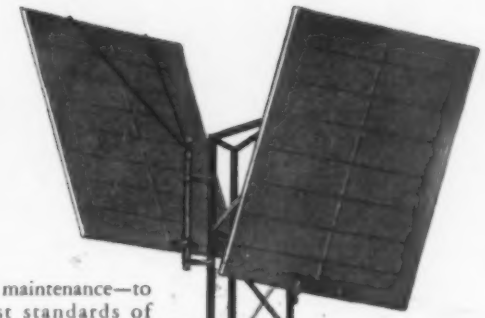

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Philco CLR-9 microwave delivers outstanding system reliability, economy of installation and operation, simplified equipment maintenance for dependable pipeline communications. With 240 voice channel baseband capacity—for telephone, telemetering and remote control—and capability for handling high-speed computer data transmission—Philco microwave fills both immediate and long-range requirements of modern pipeliners.

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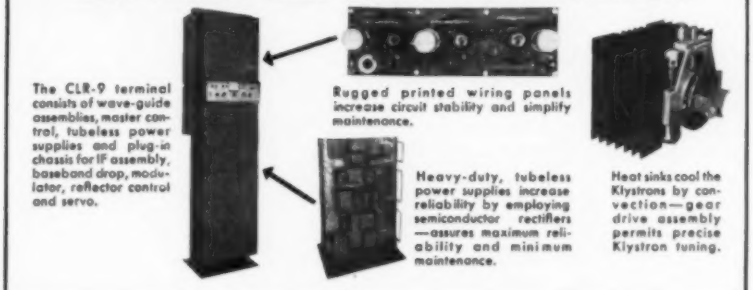

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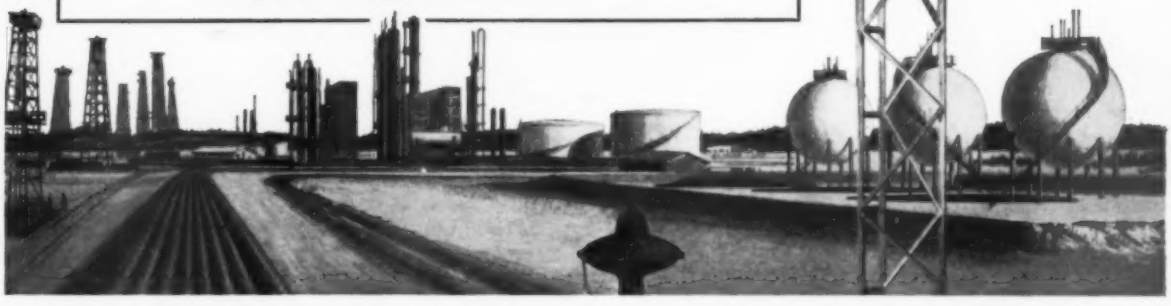

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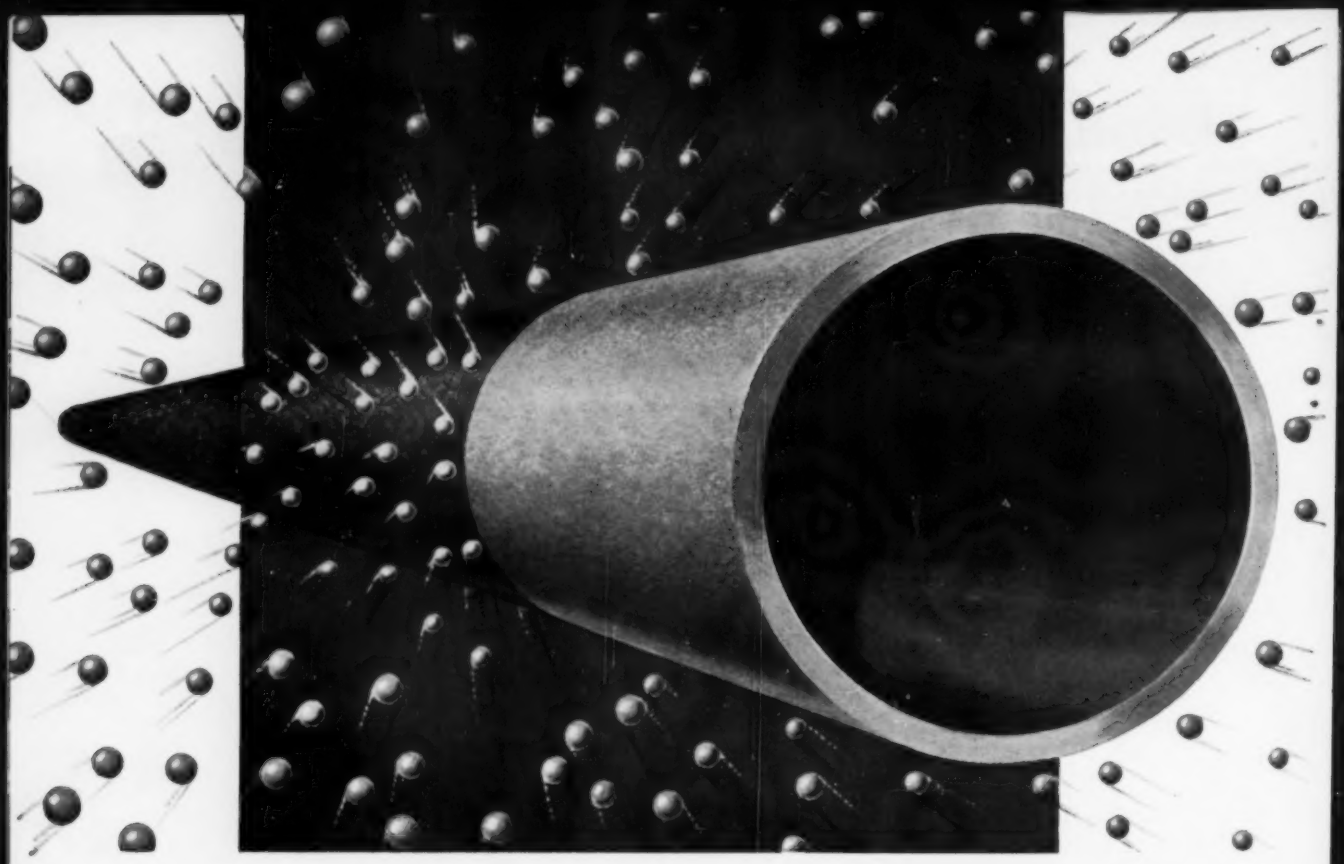

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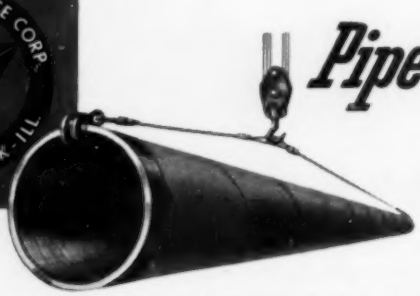

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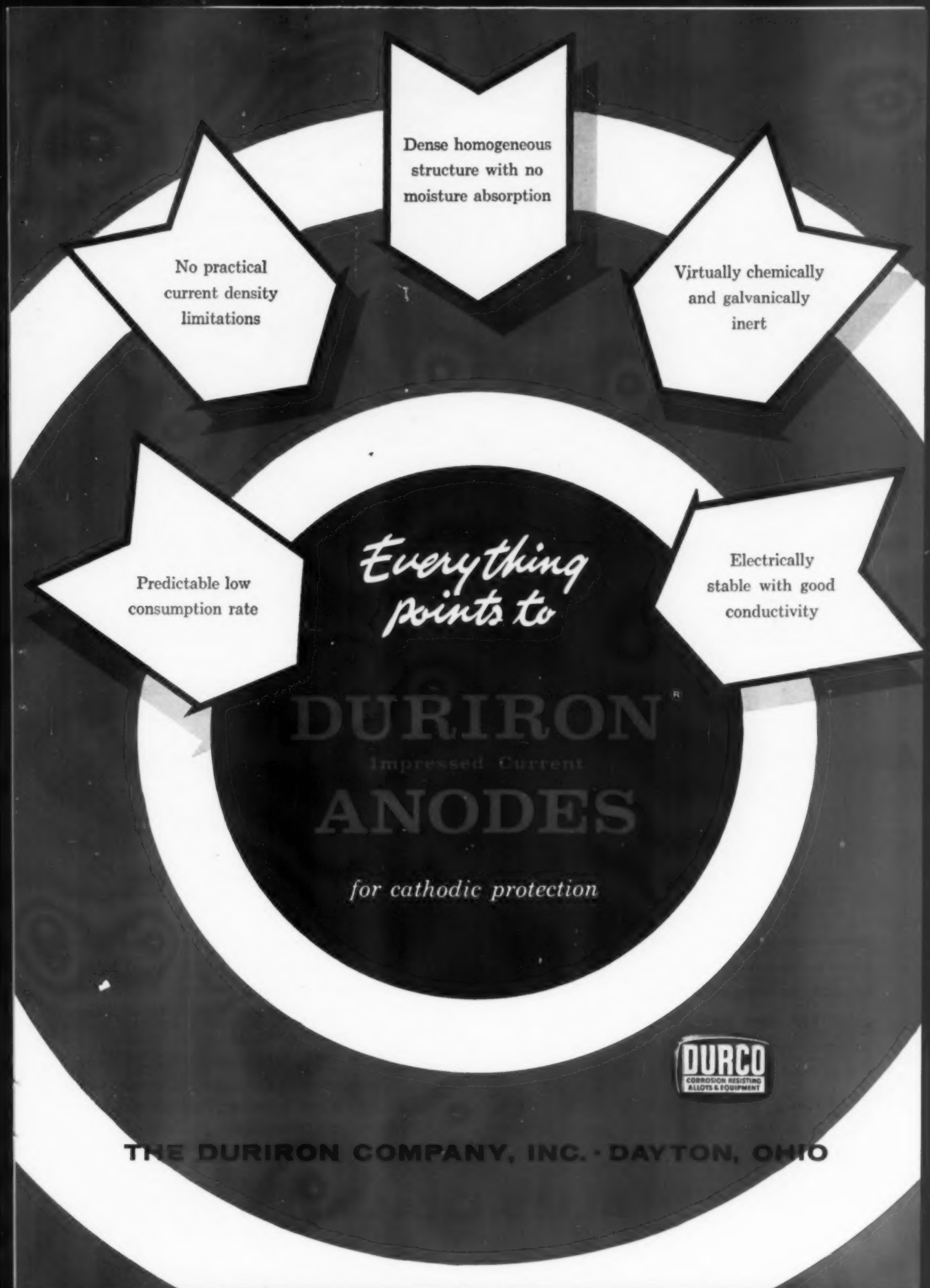
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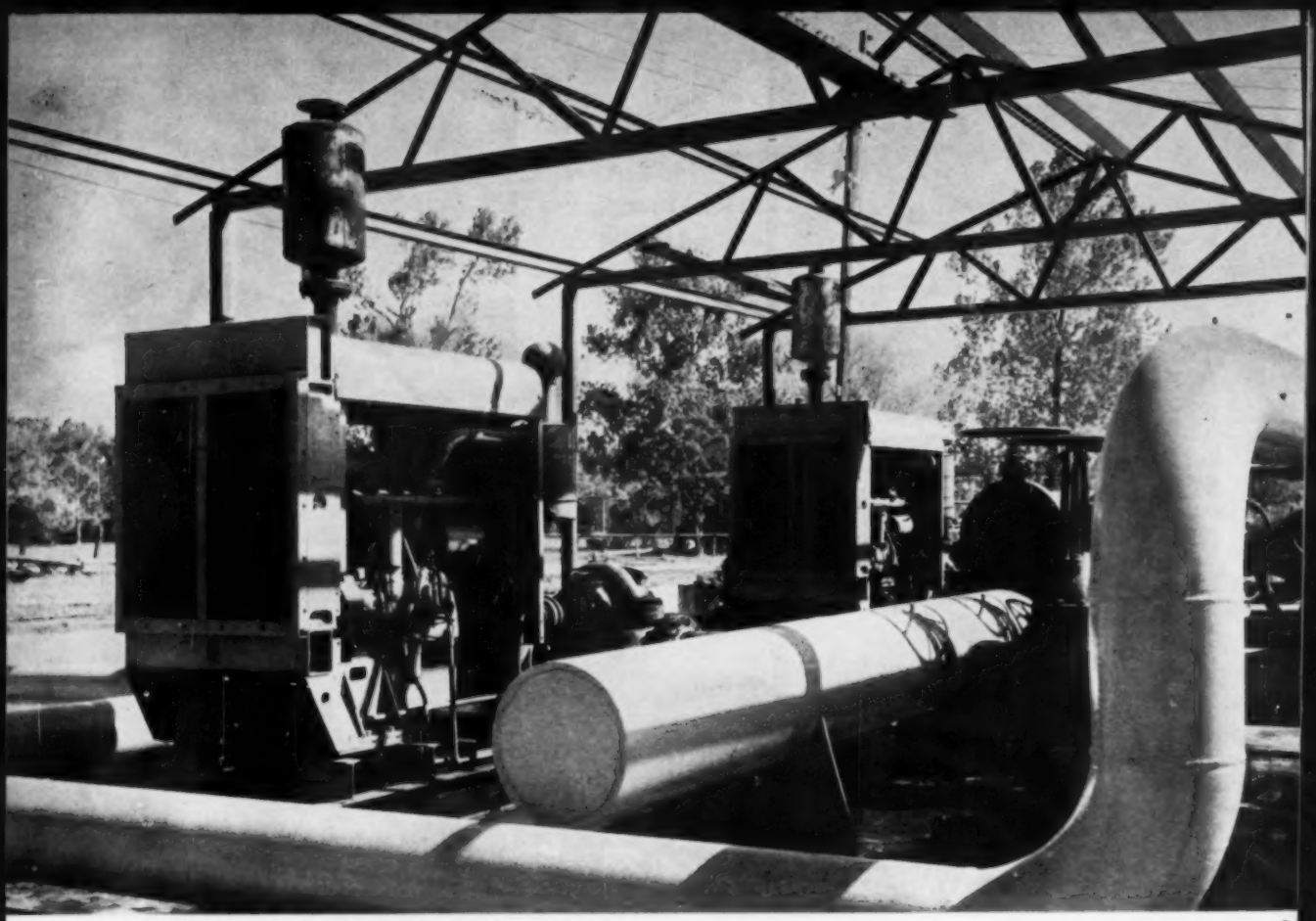

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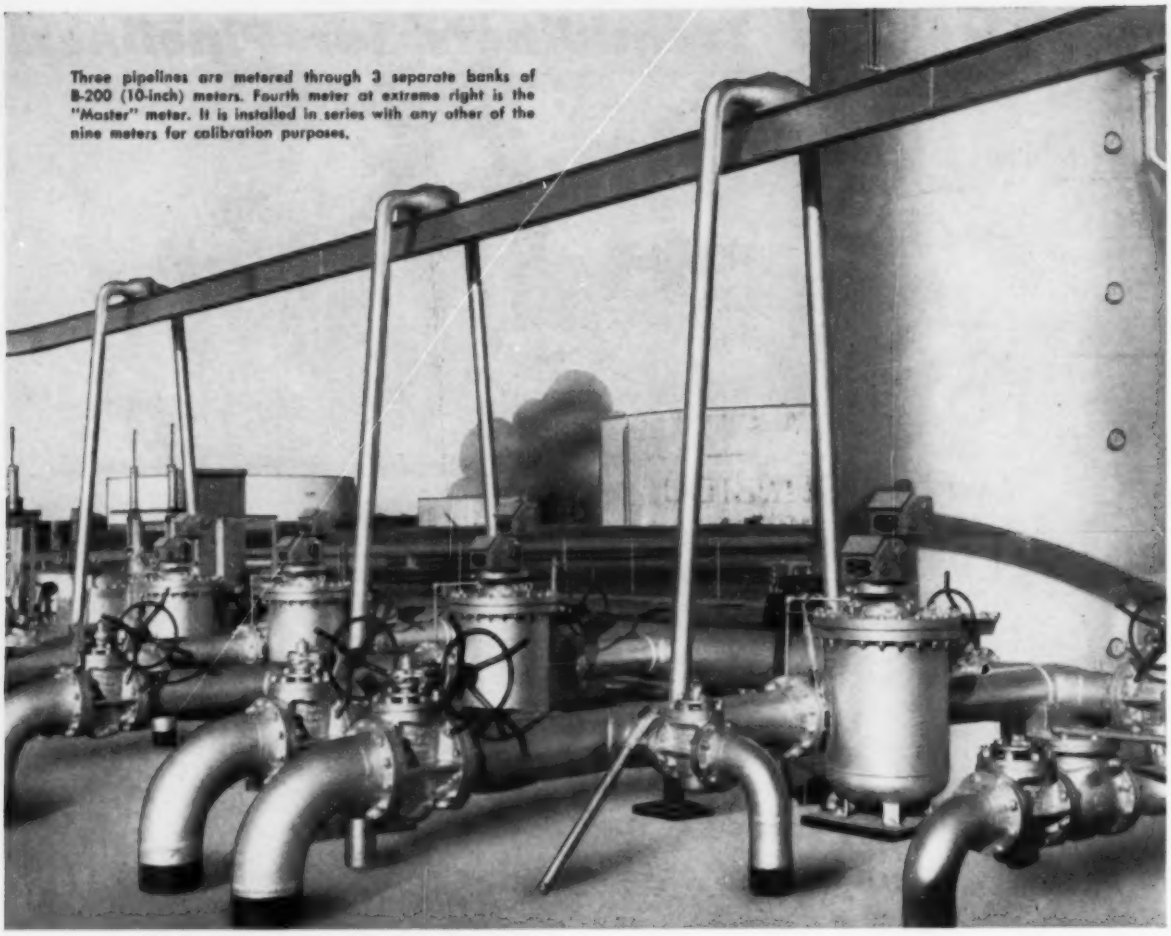

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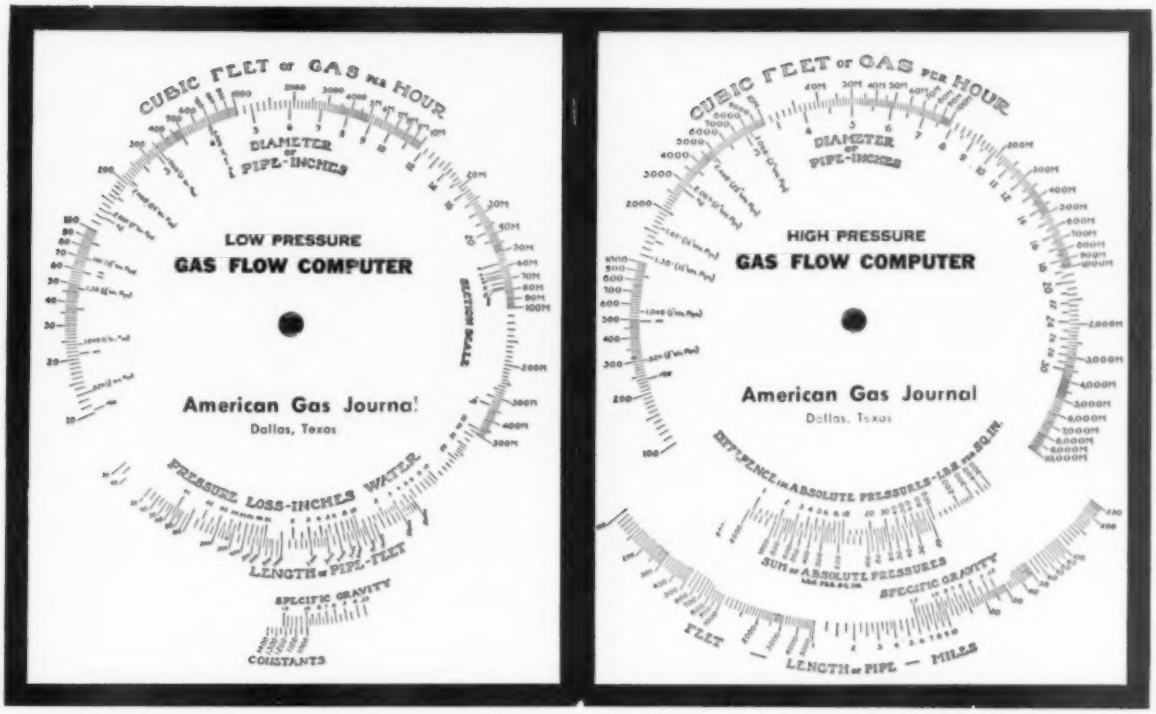
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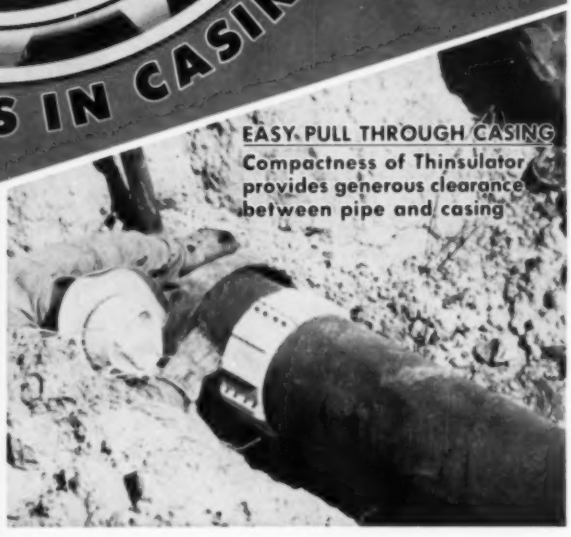

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SPECIAL FEATURE

GRAPHIC ENGINEERING DIGESTS

of TECHNICAL ARTICLES Presented at the Convention of the American Society of Civil Engineers, Pipeline Division, Chicago, Ill., February 24 to 28, 1958 Digested by Donald M. Taylor

Key men at the convention dinner —

Left to right:

Joe B. Spangler, *Transcontinental Gas Pipe Line Corp., Houston, Texas, secretary of the ASCE Pipeline Division.*

E. V. Hunt, *chief engineer, Alberta Gas Trunk Line Company, Ltd. Chairman of the ASCE Pipeline Division.*

William R. Connole, *Commissioner, Federal Power Commission, Washington, D. C.*

Fred C. Culpepper, *Ford, Bacon and Davis, Member Executive Committee, ASCE Pipeline Division.*

AUTHORS OF THE PAPERS DIGESTED IN THE NEXT 15 PAGES:

R. F. Bukacek, chemical engineering department of the Illinois Institute of Technology. BS in chemical engineering, University of Iowa, 1949; MS in chemical engineering, Illinois Institute of Technology and MS, gas technology, IGT, 1951. Worked for North Shore Gas Company 1951-52, and for Institute Gas Technology 1953-57.

John H. Wolvin, manager of Chicago Aerial Survey is a graduate of the University of Texas in mathematics and astronomy with minor in physics. Research physicist at Wright Air Development Center, Dayton, Ohio. He has been with CAS since 1952; lecturer in chemical engineering department, Northwestern University.

Clem D. Richardson, assistant superintendent of pipelines, Transcontinental Gas Pipe Line Corporation. BS, University of Kansas, 1930, in electrical engineering; 15 years working for Natural Gas Pipeline Company of America where he was field superintendent. Joined Transco in 1950.

Jack N. White, superintendent of pipelines, Panhandle Eastern Pipe Line Company, Kansas City, Missouri. BS in engineering physics, University of Kansas, 1949. He joined Panhandle in 1949 and transferred to pipeline department in 1954 as assistant superintendent. Has held present position since 1956.

R. E. Kling, Mississippi River Fuel Corporation, St. Louis, Missouri, is chairman of ASCE Pipeline Division Committee on Session Programs. His committee helpfully collected the information on movies for pipeliners which is presented in full along with these digests.

A. G. Barkow, Natural Gas Pipeline Company of America, has been engaged in metallurgical and welding development for 27 years. He is chairman of Chicago Section—Society for Non-Destructive Testing; secretary of API-AGA Joint Committee on Oil and Gas Pipeline Field Welding Practices.

THE THREE MOST USED GAS FLOW EQUATIONS & CORRECTION FACTORS

		Design Efficiency - %
WEYMOUTH	$Q_b = 433.5 \left(\frac{T_b}{P_b}\right) D^{8/3} \left[\frac{P_1^2 - P_2^2}{GTL}\right]^{0.5}$	110
PANHANDLE A	$Q_b = 435.7 \left(\frac{T_b}{P_b}\right)^{1.0788} D^{2.6182} \left[\frac{P_1^2 - P_2^2}{G^{0.8539} TL}\right]^{0.5392}$	92
NEW PANHANDLE	$Q_b = 737 \left(\frac{T_b}{P_b}\right)^{1.02} D^{2.53} \left[\frac{P_1^2 - P_2^2}{G^{0.961} TLZ}\right]^{0.51}$	90

Note - Weymouth and Panhandle A equations as written do not include the compressibility factor.

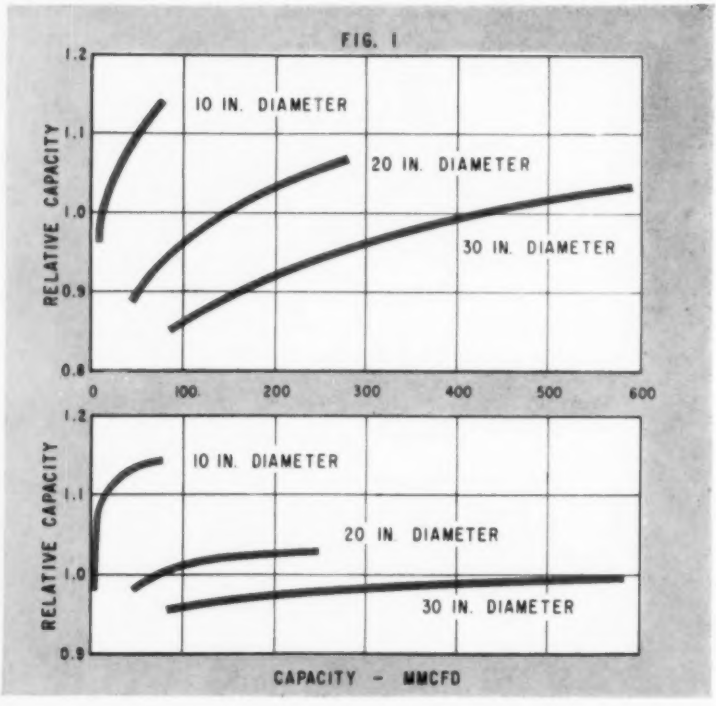
How accurate are these gas flow equations?

— *and how does accuracy affect their use?*

by R. F. Bukacek, *Chemical Engineering Department, Illinois Institute of Technology*

Conclusion. In some applications, the data required for use of flow equations are sufficiently inexact that there is no real basis for distinguishing among the above flow equations on the basis of their accuracy. This is not the case for pipeline capacity test data; since the different equations do not agree on the effect of flow rate or pipe diameter on pressure drop, the equations are not equally good. Consideration of the available data on resistance coefficients, and the conditions of natural gas pipeline operations leads to the conclusion that an equation of the "Weymouth" type is most satisfactory for large diameter lines. Because resistance coefficients for pipeline operating conditions are fixed by the internal surface of the pipe, no two pipe sections will be exactly the same, although it is to be expected that in natural gas service they will not vary too widely. While it may be possible to develop a flow equation with somewhat better properties than those currently available, it will always be necessary to use an efficiency or experience factor to account for the unpredictability of pipe surface condition.

How the equations compare



Comparison of Panhandle-A with Weymouth Design Basis

These two agree only over the range of flows which correspond to ordinary design conditions.

Comparison of New Panhandle with Weymouth Design Basis

They agree quite well for sizes above 20-in., but differ widely at smaller diameters. In general all three equations agree within 4 percent over the range of ordinary design flow rates for pipe sizes above 20-in.

Three main uses — and how accuracy affects them

1. Design of Pipelines for Capacity

An estimate of future requirements is the basis of capacity design. Because of the uncertainties of market growth, etc., the absolute accuracy of the flow equation used in this design is not too significant. In general, it would be desirable that the flow equation yield somewhat conservative results so that a margin of safety in operation would be obtained.

Flow equations contain correction factor. The practice in design has been to use one of three equations to predict flow — then correct the results with an experience factor, generally called "Pipeline Efficiency." Actually, the numerical value of this correction factor depends on: (1) Which equation is used, (2) terms included in the equation, and (3) the experience in applying the equation to a particular company's past operations.

2. Pipeline Operations Study

Flow equations are also used to study the behavior of a system under various operating conditions. Where interruptible customers are spaced along the line it is desirable to determine the most economical way of curtailing services.

Another example is determination of system capacity given compressor station outage or similar contingency. **The equations given are probably equally good for studies of this type which are necessarily based on estimated system loads.**

3. Pipeline Capacity Testing

Because pipeline throughputs vary widely, selection of an equation for this study is more critical than for the uses listed above. To illustrate, Fig. 1 shows that Panhandle A and Weymouth agree exactly on a flow rate of 425 MMcf per day for a 30-in. line, yet show a difference of 7.5 percent in prediction at 200 MMcf per day. Assuming the Weymouth efficiency to be correct throughout the range, then the Panhandle A equation would show an efficiency at 200 MMcf per day of about 100 percent rather than the 92 percent used as basis for design. **This means that the significance of efficiency test results depends on the equation used, and a change in efficiency may be due to the flow equation used rather than a change in pipe conditions.**

Fig. 1 also shows the equations are inconsistent in regard to the effect of diameter especially in smaller sizes. Thus, the meaning of efficiency tests results is dependent on pipe diameter, flow rate, and the equation used.

The flow equations and the resistance coefficient

To clarify the differences between flow equations, it is necessary to consider that all these equations arise from consideration of the balance of energy across a pipeline section operating at steady state condition. This balance may be written in differential form as follows:

$$dE + d(PV) + \frac{dv^2}{2g_c} + \frac{g}{g_c}dh = q - W_s \quad \ldots\ldots\ldots 1$$

E is the internal energy per pound of fluid.

PV is the product of pressure and specific volume. The differential represents the net work involved in forcing a pound of fluid into and out of the incremental pipeline section considered.

$\frac{v^2}{2g_c}$ is the kinetic energy per pound of fluid.

h is the elevation of the gas stream above some reference plane.

q is the heat transferred per unit mass of the gas.

W_s is the shaft work done by the gas on the surroundings in passing through the incremental section considered.

The change in kinetic energy is negligible under the operating conditions of most pipelines. Additionally, it is convenient to consider W_s and dh to be zero, that is, that the pipeline is horizontal and that no shaft work is done on or by the gas in passing through the section. The resulting equation:

$$dE + d(PV) = q \quad \ldots\ldots\ldots 2$$

is correct within the limitations imposed above, but yields no information about the effect of line length or pipe diameter on pressure drop. To obtain such a relationship it is necessary to introduce additional ideas. The concepts of friction and resistance coefficients will suffice. If friction is considered a form of energy transformation corresponding to the non-ideal behavior of the system, we can conveniently write

$$dE = q - PdV + F \quad \ldots\ldots\ldots 3$$

where F represents an energy transformation not accounted for in the heat transfer or PdV term. Combining Equations 3 and 2:

$$VdP + F = 0 \quad \ldots\ldots\ldots 4$$

Having introduced the concept of friction, its correlation with the variables of line length and diameter must be considered. This could be done in various ways, but it is conventionally done through the resistance coefficient as follows:

$$F = 4f\left(\frac{v^2}{2g_c}\right)\frac{dL}{D} \quad \ldots\ldots\ldots 5$$

This form is the simplest way to introduce the variables of flow rate, length and diameter in a dimensionally consistent way. Combining Equations 4 and 5 we have that equation which when integrated is the ordinary flow equation.

WHAT VALUES FOR RESISTANCE COEFFICIENT?

From the definition, the behavior of the resistance coefficient must be determined by the analysis of experimental data. Dimensional analysis shows that the Reynolds number may be a correlating parameter, but does not tell what relationship between resistance coefficient and Reynolds number exists. Similarly, if it is supposed that conduit surface characteristics may be important, the dimensionless group k/D may be a correlating parameter where k is the effective height of surface irregularities. There is, however, no escape from an experimental study of the resistance coefficient.

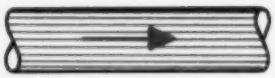
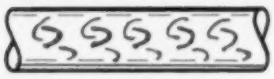
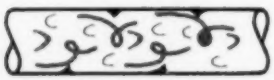
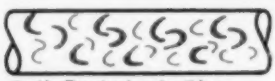
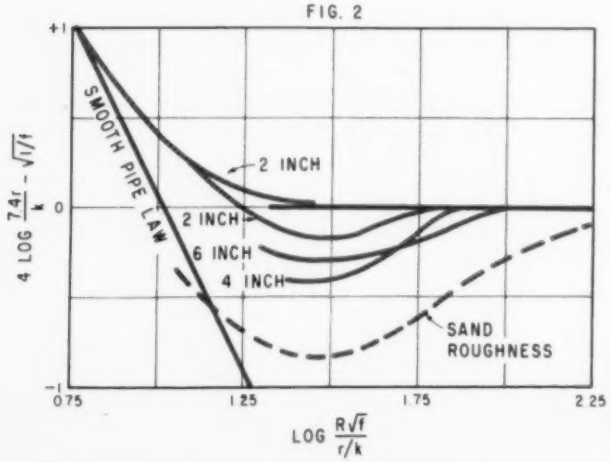
HOW GAS FLOWS	TYPE FLOW	NOTES	PRACTICAL ASPECTS
 Streamline Flow	Stable	Reynolds Number is below 2000 $f = \frac{16}{Re}$	Viscosity of Natural Gas very small - Reynolds Numbers Characteristics of Gas Pipelines very large. Streamline Flow not involved in a Practical Gas Line.
Turbulence begins near Center	Transitory	Reynolds Number about 2000 plus	Not a Practical Consideration in Pipeline Flow.
 Streamline Flow near Conduit Walls - Turbulent Flow near Center.	Stable	Approx. Resistance Coefficient $f = a Re^{b}$	Flow Pattern Equivalent to Flow in Perfectly Smooth Pipes.
 Transition to full Turbulent Flow	Transitory	Thickness of Streamline Boundary Layer Decreases as Re Increases until Turbulence Introduced at Irregularities on Conduit Surface	This Transition Depends on Conduit Surface Roughness in a Complex Way. Transition begins when Fluid Velocity at largest Roughness Elements Induces Turbulence over and above that at the Core.
 Full Turbulent Flow	Stable	The Transition to Full Turbulence will be Different for Different Pipes	Variance not too great - Corrosion, Wetness, Cleanliness affect it. Past History is Important.

FIG. 2



TRANSITION REGION

Types of resistance coefficient behavior have been established by the work of many investigators. Outstanding among them is Nikuradse whose experimental work on pipes coated with uniformly sized sand grains first convincingly demonstrated the existance of the region controlled by surface conditions. Nikuradse's work has been recently confirmed by Smith[2] et al whose experimental data on commercial pipe in the size range from 2 to 8-in. diameter has extended the range of Reynolds number investigated to 11×10^{6}. The most recent investigation covering large diameter natural gas pipelines, soon to be published by the Institute of Gas Technology, also confirms the basic patterns of resistance coefficient behavior outlined above.

NOTES ON RESISTANCE COEFFICIENTS

Reynolds Number and Pipeline Flow

Viscosity of natural gas is very small and Reynolds numbers are so large, that for high-pressure lines above 10-in. only the very small flow rates even approach the region where resistance coefficients depend on Reynolds numbers.

EXAMPLES — To achieve Reynolds number as small as 1,000,000 in 12-in. line, the flow rate must be 10 MMcf per day. In 30-in. line, it must be only 26 MMcf per day.

CONCLUSION — Flow equations which are based on an expression for resistance coefficient showing little or no dependence on Reynolds number are best for high-pressure pipelines.

Friction Factor Weymouth Equation	$f = \frac{0.008}{D^{1/3}}$	Shows no dependence on Reynolds number, agreeing with findings of Nikuradse and Smith for large Re numbers.[2]
Panhandle A and New Panhandle	$f = a\,Re^{b}$	Leads to substantial deviation from realities of pipeline operation. See New Panhandle in Fig. 1. Dependence of f on Re number for larger sizes of pipe is small in the ordinary range of flow rates.

Conclusion

It would be expected that efficiencies based on Weymouth or New Panhandle would be little dependent on the rate of flow chosen for test — efficiencies from Panhandle A would decrease with increasing flow rates. Considering range of commercial flows, Weymouth and New Panhandle equations will be more consistent with known behavior of pipelines than Panhandle A.

Realistic Approach

Interior of pipe walls vary with storage, cleanliness, corrosion, and changes may occur with time. A flow equation, at best, must take into account the fact of surface control over friction factor and contain an experience factor (or efficiency) which is not a function of pipe diameter but which distinguishes between clean commercially smooth lines and those not so clean and smooth.

Basis of a Practical Formula

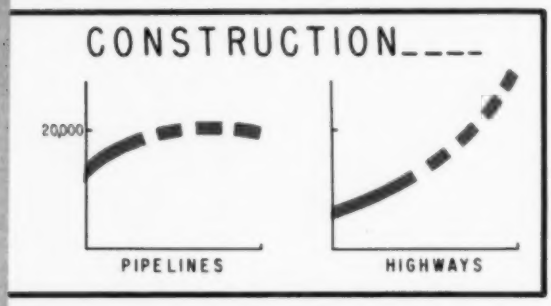
Practical variation in pipe roughness is small — there is a practical upper limit to smoothness and an effective roughness which characterizes the general run of pipelines. Data cited by Smith, et al[2] who recommended for the range of large Reynolds number the Nikuradse Rough Pipe Law $\left(\sqrt{1/f} = 4 \log \frac{3.7D}{k}\right)$ with the value $k = 0.0007$ to represent the "average" pipeline surface condition. It is also confirmed by the data of Ivey and Dorough[1] obtained on Southern Natural Gas Company's system. It should, therefore, be possible to devise an equation characterizing the commercially "smoothest" pipe to which an efficiency (or experience factor) with a value approaching unity can be applied for particular pipelines or for design purposes.

References

[1]Ivey, W. T. and Dorough, J. H., *Flow of Natural Gas in Pipelines;* Proceedings of the American Society of Civil Engineers, Paper 1194 (1957).
[2]Smith, R. V., Miller, J. S., and Ferguson, J. W., *Flow of Natural Gas Through Experimental Pipe Lines and Transmission Lines;* BU Mines Monograph 9, 1956.

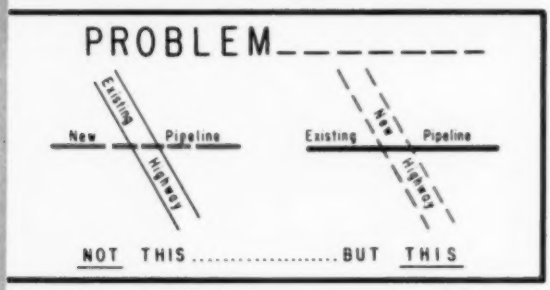
How Highway Engineers and Pipeliners can solve mutual problems — and save money!

by **C. D. Richardson,** *Assistant Superintendent of Pipelines, Transcontinental Gas Pipe Line Corporation, Houston*

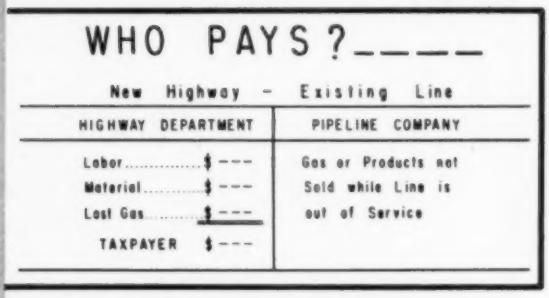


With pipeline construction continuing at a rapid pace and highway construction increasing as its multi-billion-dollar program gets underway, difficult and expensive crossing problems are arising.

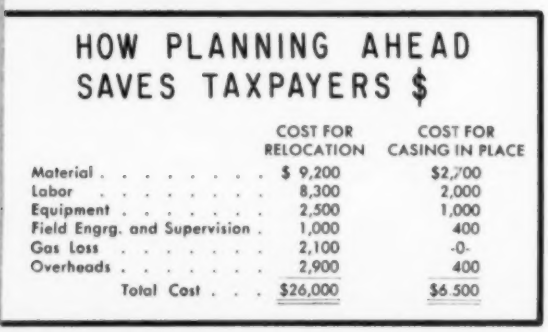
FOR EXAMPLE, Transcontinental Gas Pipe Line Corporation spent more than $100,000 last year in re-locating, lowering and casing pipelines to accommodate new highway construction. Yet the interstate highway program still is in its infancy! Projects already scheduled for this year will multiply this figure many times.



Pipelines are constructed in accordance with codes that scrupulously guard the safety of the public. Moreover, the original design and construction in accordance with the code presents no serious problems to the pipeline companies, but to revamp an operating line to conform with code requirements for *new* highway crossings gives rise to problems requiring considerable planning and expense.


WHO PAYS?
New Highway - Existing Line
HIGHWAY DEPARTMENT
Labor ... $ ---
Material ... $ ---
Lost Gas ... $ ---
TAXPAYER $ ---
PIPELINE COMPANY
Gas or Products not Sold while Line is out of Service

In nearly all instances pipelines are reimbursed by highway departments for material and labor costs incurred in revamping pipeline facilities to accommodate new highway construction. In addition, gas companies are reimbursed for gas lost when it is necessary to cut and relocate the line. However, the sale price of gas which companies are unable to deliver while a line is out of service is not recoverable.



	COST FOR RELOCATION	COST FOR CASING IN PLACE
Material	$ 9,200	$2,700
Labor	8,300	2,000
Equipment	2,500	1,000
Field Engrg. and Supervision	1,000	400
Gas Loss	2,100	-0-
Overheads	2,900	400
Total Cost	$26,000	$6,500

Many highway engineers persist in disregarding pipelines in the path of new highways. This may stem from their lack of knowledge of the paramount rights of the pipeline right-of-way and of the great cost of relocating an operating line.

Differences in cost of relocating and casing crossings. If a pipeline must be relocated only slightly to accommodate a new highway, the costs as compared with a simple casing job usually run about 4 to 1. The costs at left are typical.

These savings should be pointed out to highway engineers — after all, it is the highway department who will benefit most.

What's involved in installing 142 ft of casing

What's involved in casing and lowering a pressured line.

This job is like carrying a basket of eggs – as long as everything is handled properly there will be no cracked eggs — or in this instance, pipelines. Here are a few basic rules our company follows when installing casing on a loaded line:

1. Either use company forces, or select a contractor with the greatest know-how.
2. Set up minimum distances for operating excavating equipment. The line itself must be uncovered with hand tools.
3. The casing should be 4 in. larger than the pipe.
4. The pipe must be completely free from earth so the split casing will roll under it.
5. With the pipe already under hoop stress from gas, it should not be subjected to abnormal stress from external forces. Limit the excavated span between supporting earth-bearing points to the minimum required to install 30 or 40-ft lengths of casing at a time.
6. After the first length of casing is installed, well-tamped soil or sand is worked underneath the casing to restore load-bearing surface. This process is repeated for the rest of the casing.
7. Where required by highway authorities to backfill with sand, some disposition must be made of the earth originally excavated.

What happens without notification – discussion

Fig. 2 and 3 show troubles at the crossings. Fig. 2 shows plans for a highway crossing an existing line without regard to its location. Casing requires mitre welding and if any trouble should ever develop it would be necessary to cut the highway to make repairs. Fig. 3 shows the results of lack of notification and discussion. Just a year before this highway location was announced, we checked with the highway department before relocating valves to the present position. Now they must be moved again as shown. Proper planning and notification could have saved the taxpayers great expense.

How joint cooperation can work

See Fig. 4. When highway authorities in an eastern state announced that we would have to relocate our single line to our market, they also agreed to provide us with the R-O-W required for relocation. We requested that the highway defer construction until we could accelerate construction of a second line we had planned. This would allow us to continue service to customers during relocation. Unfortunately, the State bogged down in getting approval for its highway, while we obtained approval for our line. This means that if we proceed with the construction of a second line, the State will have double expense at this point. We are urging them to step up their program in time to save a great sum of money.

FIG. 1

PARTICULARS	UNIT	QUANTITY	UNIT PRICE	ESTIMATED EXPENDITURES (* DENOTES NON-CASH) MATERIAL AND EQUIPMENT	LABOR	OTHER COSTS	TOTAL
Pipe, Valves & Fittings							
(1) Casing—16" x .375" W.T. to be split in Field Forms	Ft.	142	15.72	$ 2,230.4*			$ 2,230
(2) Casing End Seals, Mulcay Slipper Type	Ea.	2	60.00	120			120
(3) Casing Insulators, For Insulating 20" O.D. Pipe & 16" O.D. x .375 W.T. Casing	Ea.	8	30.00	240			240
(4) 24" x 12" x 16" O.D. Reinforced Tee	Ea.	1	5.60	5			5
(5) Pipe, 24" x .344 WT Test Pipe	Ft.	10	90	9			9
(6) Mile Post Marker-Obstacle Concrete	Ea.	1	5.00	5			5
(7) Miscellaneous Material, Welding rod, acetylene, oxygen, coating material, etc.	Lot	1		100			100
(8) Equipment Use	Lot	1				1,000	1,000
(9) Stream Crossing		$1,250	50%			625	625
(10) Installation of Casing—Cleaning Line to Drill Casing—Haul to Job site & Install	Lot	1			2,375	500	2,875
(11) Bonus, Insurance & Taxes					960		960
Subtotal-30, Pipe, Valves & Fittings		$ 2,375	10.3%	$2,715	$3,335	$1,625	$7,675
Field Engineering & Supervision							
(1) Labor & Other Costs		2,190	%		190	30	220
(2) Vacation & Holidays		2,500	%		160		160
(3) Bonus, Insurance & Taxes		190	10.3%		13		13
Subtotal-35, Field Engineering & Supervision					$ 363	$ 30	$ 393
Total Direct Cost				$2,715	$3,698	$1,655	$8,068
Design, Engineering, Supervision Drafting, Purchasing, and other General Administrative Costs		$3,698	15%			$ 555	$ 555
TOTAL EXPENDED COST				$2,715	$3,698	$2,210	$8,623
Note: All Materials to be requisitioned by Pipe Line Dept., etc.							

FIG. 2

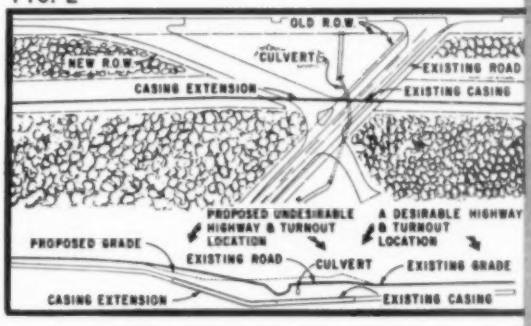


FIG. 3

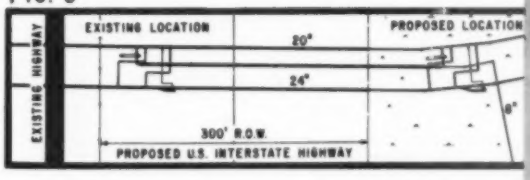
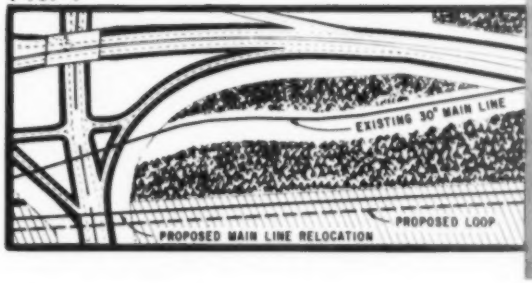


FIG. 4



THE BEST SOLUTION

NOTIFICATION
DISCUSSION
COOPERATION
} = $ SAVINGS FOR ALL

What can be done.

Highways cannot be designed to accommodate pipelines, yet often a road can be relocated a few hundred feet — or grade added instead of removed — at a great savings to both State and pipeline company.

Authorities could help the pipeline companies and themselves by setting up departments to approve our construction drawings as designed to accommodate highway construction. This way we will be assured of meeting highway requirements at great savings for the State.

Given advance information, pipeline companies will happily provide profiles and other information required throughout proposed highway construction areas across pipeline right-of-way. In many cases, if we could have exact information in advance about the location of proposed highways, we could install casing during our regular pipeline construction.

By conferring together we can work out our problems!

All of this will result in the cooperation necessary to produce a better and less expensive job for all concerned.

Where to get Pipeline Movies

Robert E. Kling,
Mississippi River Fuel Corp., St. Louis, Missouri.

"PIPELINE OF PROGRESS"

16 mm; color; sound; R.T. 26½ min. Phases of construction, including techniques used in marshes, river crossings, rough terrain, etc.
Contact: American Louisiana Pipe Line Company, F. H. McIntire, Assistant to the President, Penobscot Building, Detroit 26, Michigan.

"BIG CROSSING"

16 mm; color; sound; R.T. 35 min. Construction of the Interprovincial-Lakehead 1772 mile crude-oil pipeline system from Edmonton, Alberta, to Sarnia, Ontario.

"NATURAL GAS IS ON THE WAY"

16 mm; color; sound; R.T. 25 min. A work-in-progress report on history and construction of a 650 mile natural gas pipeline from the Peace River district to Vancouver.

"OIL ACROSS ARABIA"

16 mm; color; sound; R.T. 40 min. Engineering, logistics and construction of the 1068 mile 30 to 31-in. trans-Arabian Pipeline System from the oil fields of Saudi Arabia to the Mediterranean Sea.

"OIL ACROSS THE ROCKIES"

16 mm; color; sound; R.T. 40 min. Trans-Mountain Oil Pipeline Company's 718 mile crude-oil artery from fields near Edmonton, Alberta, to Vancouver, British Columbia. For the above films *contact*: R. M. Dorman, Manager Public Relations Department, Bechtel Corporation, 220 Bush Street, San Francisco, California.

"THE ETERNAL FLAME"

16 mm; color; sound; R.T. 29 min. Development of the gas industry from the discovery of the famous spring in the 1700's to the present time.

"MORE GAS IN CENTERVILLE"

16 mm; color; sound; R.T. 12½ min. Long distance transmission lines, city distribution and underground storage, graphically shown.

"RIVER IN THE WAY"

16 mm; color; sound; R.T. 17 min. Photographed in the Mississippi Delta, film describes efforts to lay pipe beneath the Mississippi River.

"THE TOUGHEST INCH"

16 mm; color; sound; R.T. 17 min. Story of a 262 mile pipeline laid despite rocks, rivers, mountains.
Contact: Columbia Gas Systems, Inc., Information Department, 120 East 41st Street, New York, New York.

"IT'S MAGIC"

16 mm; color; Magnetic Sound; R.T. 25 min. The story of one method of laying submarine pipelines to offshore producing oil and gas wells in the Gulf of Mexico.
Contact: R. C. Ledford, Vice President, Commonwealth Oil Company, Houston Bank Building, Houston, Texas.

"ASSIGNMENT ACCOMPLISHED"

16 mm; color; sound; R.T. 40 min. Traces construction of a major line between Corsicana and Beaumont, Texas, and includes sequences on pipe fabrication.
Contact: Public Relations Department, Magnolia Petroleum Company, P.O. Box 900, Dallas, Texas.

"PIPE OF PLENTY"

16 mm; color; sound; R.T. 22 min; Pipeline construction from Detroit to storage wells in Austin, Michigan, fields. 153 miles of pipeline built over toughest terrain in winter.

"REBIRTH OF A GIANT"

16 mm; sound; color; R. T. 15-in. The conversion of a depleted natural gas field to an underground reservoir. Most scenes taken in the Six Lakes area, Michigan.
Contact: Michigan Consolidated Gas Company, Attention: Noble D. Travis, Director of Public Relations, 415 Clifford Street, Detroit 26, Michigan.

"NATURAL GAS TO THE NORTH"

16 mm; color; sound; R.T. 30 min. Shows engineering and construction problems in crossing rocky terrain, two river crossings, and other aspects of construction.
Contact: Michigan Wisconsin Pipe Line Company, Attention: H. B. Martinson, 500 Griswold Street, Detroit 26, Michigan.

"WELDING AMERICA"

16 mm; color; sound; R.T. 27 min.
Contact: Public Relations Department, Natural Gas Pipeline Company of America, 122 S. Michigan Avenue, Chicago 3, Illinois.

"NATURAL GAS ON THE MOVE"

16 mm; sound; color; R.T. 14½ min. Factual story of old wells, used to store gas in summer for winter use.
Contact: Director of Public Relations, New York State Natural Gas Corporation, 140 Stanwix Street, Pittsburgh 22, Pennsylvania.

"AROUND THE CLOCK"

16 mm; color; sound; R.T. 30 min. Concerns the enormous job a gas transmission company faces each day to bring the residents of the Northern Plains gas service.

"PIPELINE IN THE SKY"

R.T. 33 min. Documentary film of one of the largest pipeline suspension bridges.
Contact: Northern Natural Gas Company, Attention: R. E. Adwers, Public Relations Department, 2223 Dodge Street, Omaha, Nebraska.

"DECISION"

16 mm; color; R.T. 28 min; sound. The little known story of the pipeline industry in America. Scenes tied to fictional story so closely, that it may have been taken from the pages of our newspapers.
Contact: The Ohio Oil Company, Public Relations Department, Findlay, Ohio.

"SUPER INCH"

16 mm; color; sound; R.T. 30 min. 1600 miles of 34-in. natural gas pipeline constructed to link Northern California and the gas field of Texas and New Mexico. Note: Pacific Gas and Electric Company normally does not send films outside their territory of service, Northern and Central California, but are making an exception, providing requests are not too heavy. For this reason, requests may not always be filled.
Contact: Pacific Gas and Electric Company, Attention: W. A. Hynes, Manager, Public Activities Division, 245 Market Street, San Francisco, California.

"THE SCENIC INCH"

16 mm; color; sound; R.T. 21 min. Construction and operation of natural gas transmission system, from production, to ultimate consumption of gas.
Contact: Public Relations Department, Pacific Northwest Pipeline Corporation, P.O. Box 1526, Salt Lake City 10, Utah.

"PIPE LINE"

16 mm; sound; color; R.T. 24 min. Saga of pipelines and the men who build and operate them.
Contact: Director of Public Relations, Shell Oil Company, 50 West 50th Street, New York 20, New York.

"UNDERGROUND MIRACLE"

16 mm; color; sound; R.T. 20 min. Laying pipelines in the Gulf of Mexico through marshes, bayous, ets. Transporting gas from distant producing fields to Southern communities.
Contact: Southern Natural Gas Company, Attention: R. G. Kenan, Watts Building, Birmingham, Alabama.

"GAS GOES TO MARKET"

16 mm; color; sound; R.T. 30 min. Construction and operation of a natural gas pipeline system carrying gas from the Gulf Coast of Texas to the Appalachian markets.
Contact: Tennessee Gas Transmission Company, Attention: D. B. Hicks, Public Relations Manager, P.O. Box 2511, Houston 1, Texas.

"UNDERGROUND HIGHWAY"

16 mm; sound; color; R.T. 22 min. How an 800 mile underground natural gas pipeline was build from East Texas to Middletown, Ohio, to enable an interstate transmission company to make larger supplies available to growing needs.
Contact: Texas Gas Transmission Corporation, Public Relations Director, 416 West Third Street, Owensboro, Kentucky.

"MAP OF AN EMPIRE"

16 mm; sound; color; R.T. 20 min. Review of growth and expansions in the Gulf South, with emphasis on the contributions being made by natural gas industries.
Contact: United Gas, P.O. Box 1407, Shreveport, Louisiana.

From the military comes a new tool for pipeliners . . .

SONNE PHOTOGRAPHY

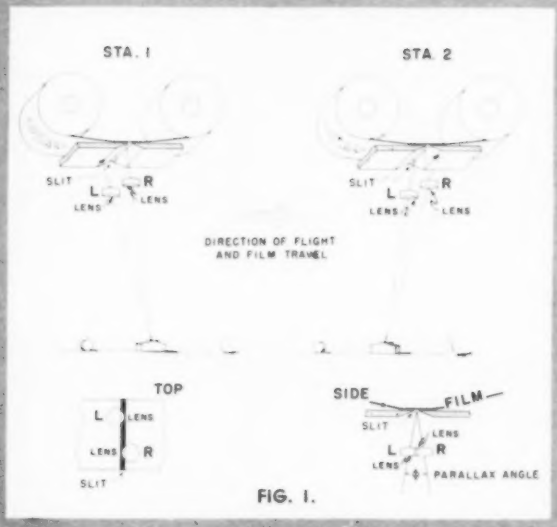


FIG. 1.

FIG. 2.

John H. Wolvin, *Manager, Chicago Aerial Survey*

SONNE CONTINUOUS STRIP CAMERA permits large scale direct aerial photography for detailed study of terrain. During the war years, this camera was extensively used for beach reconnaissance and water depth determination, as well as for detailed bomb damage assessment photography. Improvements since the war have made it an excellent engineering tool. It can be used for stereo or non stereo photography — the former, of course, is most useful.

How it works. Fig. 1 shows a schematic of the camera geometry. The narrow slit across the width of the film limits the field of view of each lens to a narrow rectangle on the ground. The right lens is forward of the film; the left one aft, separating the fields of view in direction of flight. The half film width above the right lens will record a ground object before the airplane flies over it, and the other half of the film will record the same object after the airplane has passed. The speed of the film passing the slit must be synchronized to eliminate relative motion between the image of ground objects and the surface of the film.

Actually, complex instruments eliminate blur due to the forward motion of the plane and the image is literally laid on the film as it passes the slit.

The continuous photography of the ground is only as accurate as the pilot can hold the aircraft. Altitude control and centering control are primary considerations. Mean ground elevation must be determined for flight line planning to control the aircraft clearance above the ground. Centering of the flight line can normally be held within one-tenth of the altitude, regardless of the photographic scale.

Continuous strip photography supplements rather than replaces precision mapping photography. Its primary advantage is ground detail. Because of its fidelity, enlargements up to 10 times may be made with comparatively small loss in detail. Much highway photography has been flown at scales of 100 and 250 ft per in. Sections of railroad were photographed at scales as large as 15 ft per in.!

Continuous strip photography offers certain types of precise ground measurements. By means of appropriate parallax measuring instruments cross sections may be measured and plotted. Ground controls will

WHAT ARE THESE PIPELINERS LOOKING AT?

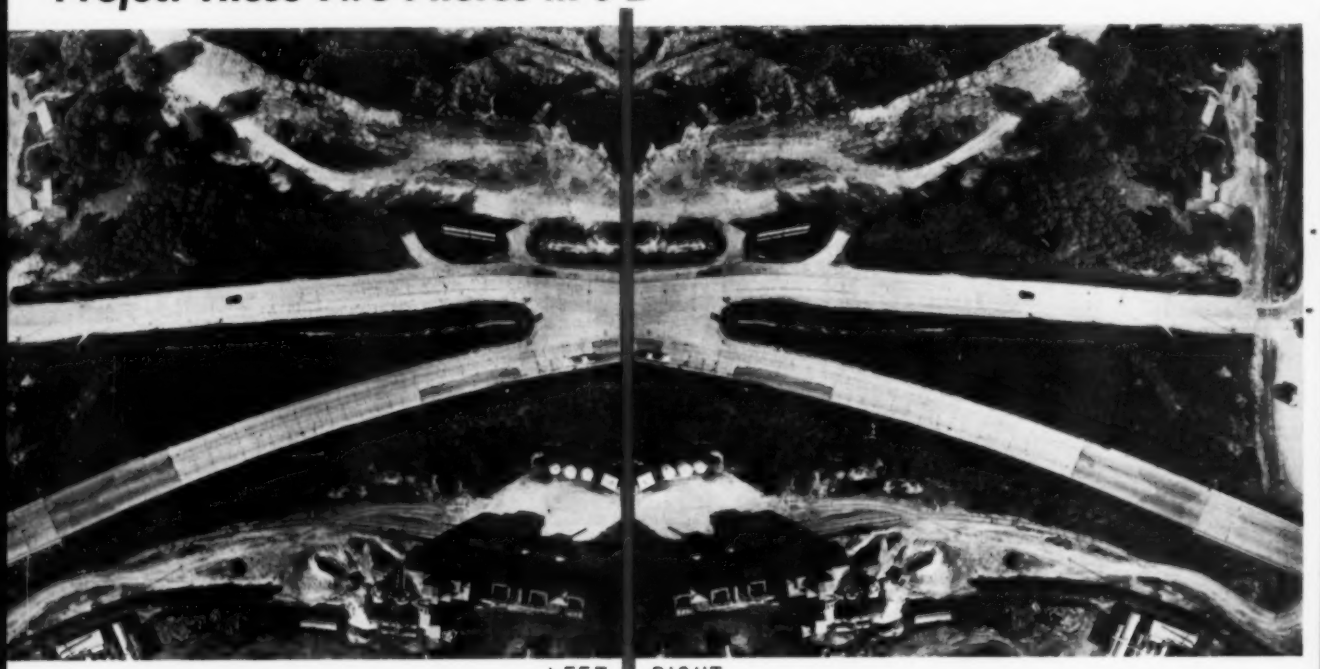
(for answer turn page)

PIPELINERS WERE WATCHING THIS SONNE PROJECTOR

enhance the accuracy of such measurements. A known width, such as that of a highway or railroad track, constitutes horizontal control and enables scale to be determined. If the camera is vertical or nearly so at the time of the exposure, relative elevations can be measured with no additional control.

An important feature is the ability to use larger than normal base-height ratios. Fig. 2 shows the base-height geometry of a Sonne camera. Note that base-height ratios of double that normally used can be obtained. This means that for the same scale of photography it is possible to obtain twice the accuracy of vertical readings with a correctly designed parallax measuring instrument.

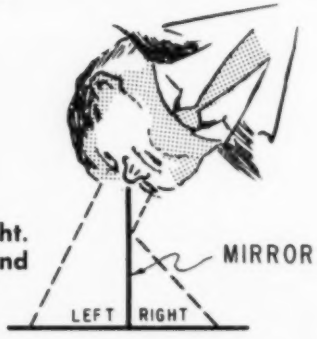
Project These Two Photos in 3 D



Depths can be measured with fantastic accuracies with the stereoscopic viewer

LIKE TO SAMPLE 3D?

Place mirror on edge on line above facing right. Then place nose on upper edge of mirror and look toward the left photo.



Measuring Flow Efficiencies by Ammonia Displacement

By Jack N. White,
Superintendent
Pipe Line Section
Panhandle Eastern Pipe Line Company

About Efficiencies

It has become apparent that large diameter pipelines have a characteristic flow efficiency that depends on internal roughness of the pipe, the bends and fittings, as well as the accumulation of lubricating oil and other material on the walls of the pipe.

It is not unusual for new lines to have initial flow efficiencies of 92 to 97 percent, depending on the smoothness of the line and what equation was used to predict the efficiency. But efficiencies drop from this initial high because of the small, but ever present quantities of water, distillate, lube oils, and perhaps dust entrained in the flowing gas stream. A periodic check of the efficiency of the line to determine when it should be cleaned to bring it back to its design or initial efficiency is an economic necessity.

How Important is Efficiency?

For each 5 percent decrease below the design efficiency, approximately 13 percent of the original line would require looping in order to restore the original capacity. Translated into dollars and cents, this means that for an existing 30-in. pipeline 100 miles long, 5 percent reduction in flow efficiency would require 13 miles of 30-in. loop, costing in the neighborhood of $1,100,000 to make it possible to flow the original volume of gas under the original pressure conditions. Compare this capital expenditure with an estimated $20,000 that would be required to clean the original line and restore it to its original capacity and the importance of flow efficiency is boldly apparent.

What is Efficiency?

Overall flow efficiency, E, is defined as the ratio of the actual measured throughput for any one section of pipeline to the theoretical throughput of the same section under the same flowing conditions of pressure and temperature. E differs with the flow equation used.

Measuring "E" with Anhydrous Ammonia

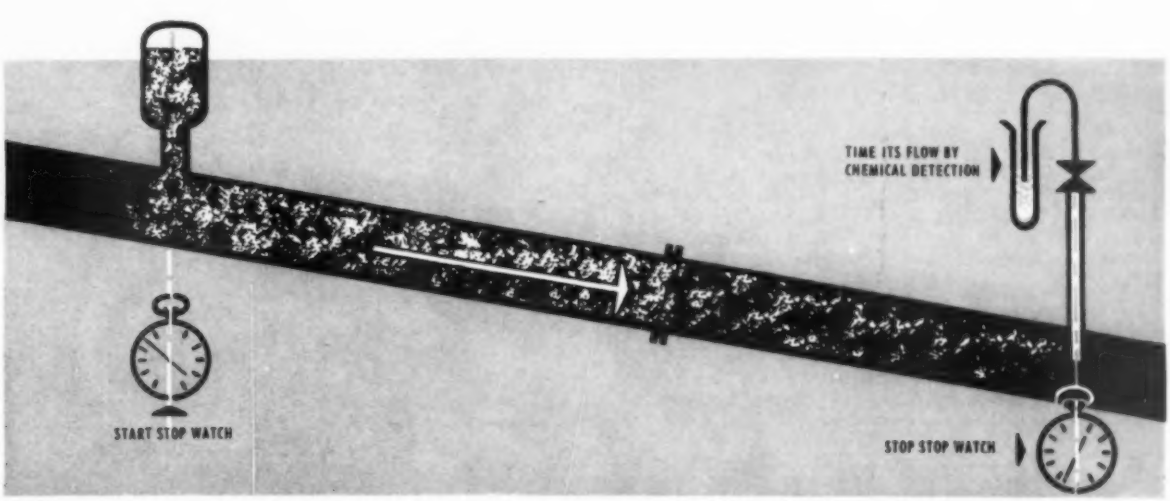
There have been numerous articles published on the ammonia displacement method of measuring pipeline flow efficiency. In a nutshell, ammonia is injected into the line and chemically detected downstream.

The object of a flow test is, of course, the collection of certain necessary data under controlled conditions. The data collected must be sufficient to solve for the theoretical throughput of a given section and the actual throughput of the same section.

The information which must be accurately gathered is:

	DATA	TOLERANCE
1.	D = Inside pipe diameter	Commercial
2.	$h_2 - h_1$ = Elevation change	± 2.50 ft
3.	L = Length of section	± 0.000 miles
4.	P_1 = Upstream pressure, psig	± 0.100 psi
5.	P_2 = Downstream pressure, psig	± 0.100 psi
6.	Pa = Atmospheric pressure, psia	± 0.050 psi
7.	Ta = Flowing gas temperature, degrees absolute	± 0.500 deg
8.	G = Gas gravity	± 0.001%
9.	Z = Compressibility	± 0.005%
10.	t = Ammonia travel time	± 0.500 sec

Items 1, 2, and 3 are fixed physical characteristics of the line. The data for items 4 through 10 must be measured in the field during the test.



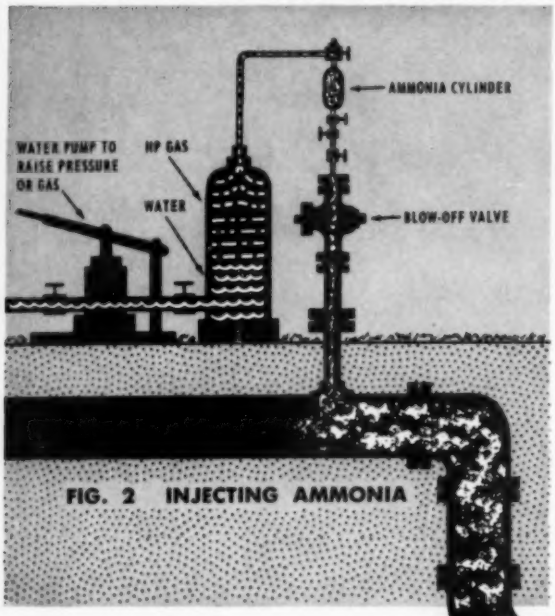


FIG. 2 INJECTING AMMONIA

2. There should be no orifice plates or valves in the line between the points of the test section.
3. There should be no major pipe junctions near the point where pressure is recorded.
4. The elevation change between the points must be readily determinable.
5. There should be no multiple sections, such as river crossings, between the end points.
6. The pipe should be cleared of removable drip fluids, etc.
7. The test section should be far enough away from compressor stations to avoid pressure pulsations.
8. The section should be sufficiently downstream from compressor stations to avoid the extreme changes found in the flowing gas stream immediately adjacent to the station discharge.
9. Main line taps that supply market areas subject to short duration pull-down should be avoided.
10. The end points of the test section should be reasonably accessible and should provide suitable appurtenances for the installation of injection and detection equipment and dead weights.

If all these conditions can be met and the upstream and downstream compressor stations are able to maintain constant discharge and suction pressures on the line for several hours preceding the test, then stable flow in the test section is closely approached.

How to Calculate "E"

By using the applicable data in the adopted flow formula, the theoretical throughput is readily determined. By applying the same flowing conditions to the physical characteristics of the section, the corrected volume of gas in the section may be determined. This volume, factored by the time that it takes a slug of ammonia to travel between the sections, produces the actual rate of flow.

Selecting a Section for the Test

Because all flow formulas are based on stable flowing conditions, the test section must be selected to provide the physical conditions most conducive to steady state flow. Even under ideal operations, it is difficult to maintain a stable flow pattern in any given point for a long period of time. This is a common source of error. The following factors must be taken into account in selecting a test section:

1. The section should be long enough to minimize error in reading pressures. A measurement error of 1/10 of a lb in the pressure drop, which would occur, for instance, in 1000 ft of pipe, would be of serious proportions. However, if the 1/10 lb error was applied to the pressure drop in a 10-mile section, the magnitude of the error becomes acceptably small. An unrestricted section between 5 and 15 miles in length gives reasonable accuracy.

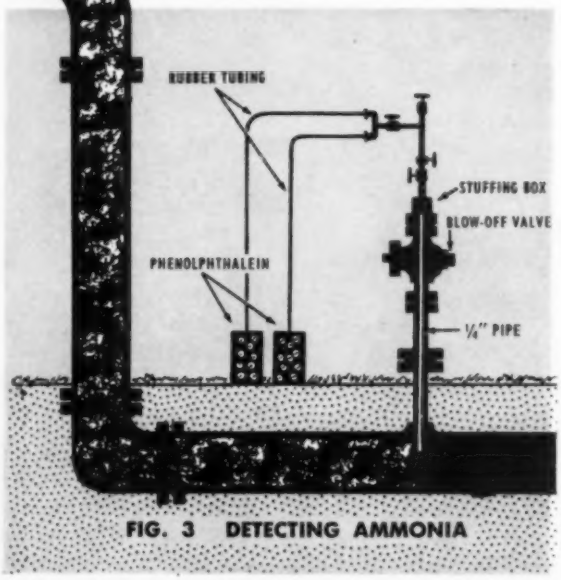


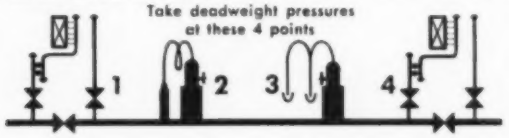
FIG. 3 DETECTING AMMONIA

Rules to Follow

TIMING

If no radio or telephone, use the same watch.

PRESSURES

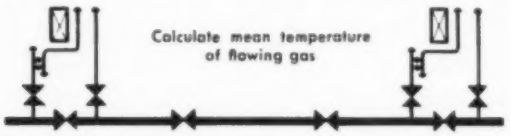


Start hour or so before test and run during test on 5 to 10 minute intervals.

FLOW

Control at upstream station with deadweight pressures.

TEMPERATURES



Measure temperatures not too close to station discharge or suction. Temperature of pipe will do.

GRAVITY

Use gravitometer — portable or fixed.
Make direct measurements to determine super compressibility.

PLANNING

1. Dispatchers should be given sufficient notice so they can stabilize system.
2. Schedule — in mid-week (?) when no cutbacks or line-packs likely.
3. Early Fall desirable — to determine whether or not will meet heavy winter loads.

SOURCES OF ERROR

1. Pressure measurement.
2. Incorrect time being communicated ahead.
3. No correction made for changes in elevation.
4. Unstabilized flow.
5. No dead weight correction made.
6. Incorrect length of line used in calculating ammonia run.

It is not uncommon for someone to forget to add the 5 lb for the weight of the table onto their dead weight reading or not add the weights on the table correctly. An error of one minute is often made in communicating the time ahead of the detection point. Elevation corrections are quite necessary in most cases.

Line stability is, of course, one of the most important points if results are to be consistent. Not all dead weights read the same and can differ as much as a pound and a half at full scale. For this reason each of your dead weights should be compared with some standard. Relative readings are the important thing and not individual readings. You can be a half a pound off, as long as all of the readings are a half a pound off and it won't make a great deal of difference, just so they are compared with one dead weight and it is used as a standard.

One of the best ways to eliminate the errors, or some of the errors, is running two slugs of ammonia. This tends to eliminate error and it tells whether or not the flow is steady. Run the slugs 20 or 30 minutes apart and compare answers. If your flow is stable, they will be close.

The importance of using the correct length of line in the test section is readily apparent.

USES

1. Design of future facilities,
2. Dispatching,
3. Flow study,
4. Determining whether the line needs to be cleaned.

NOTES

Ordinarily efficiencies to be used for flow studies and dispatching should not contain elevation corrections. For these purposes a dispatcher or engineer is interested in how much gas he can actually get through the line with the changes in elevation and not how much he can get through the line if they were not present.

Consideration should also be given to pressure drops in yard piping if present.

Elevation corrections are important, however, in determining whether a line should be cleaned. Our practice is to determine the efficiency of the entire line between two compressor stations and compare the results with those of the previous tests. Where there's a decrease, we determine the efficiency of the individual sections between the gate settings to see whether the low efficiency is due to the entire line or one or two sections.

The ammonia displacement method is economical and adaptable to most pipeline systems. It permits a high degree of accuracy under field conditions. I feel that it is the best method yet developed.

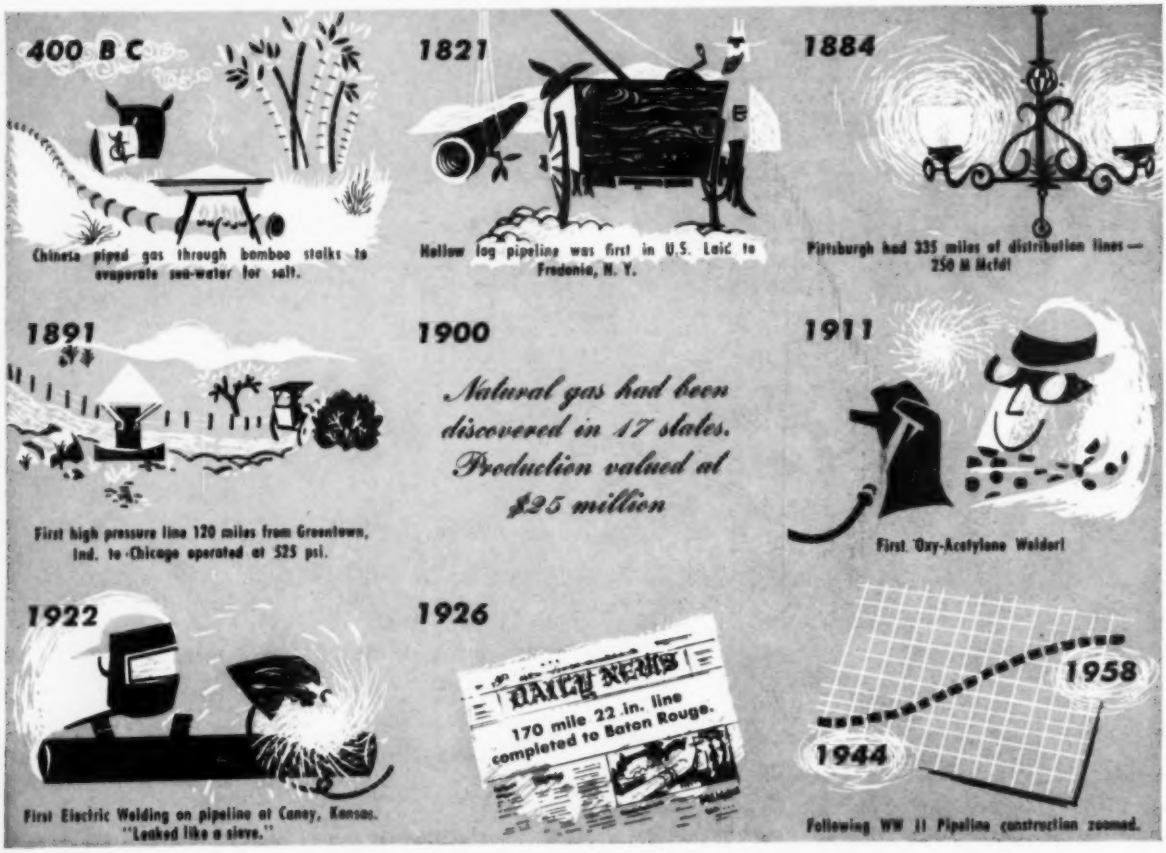
Pipeline Field Welding and Quality Control Methods

By **A. G. Barkow,** *Natural Gas Pipeline Co. of America*

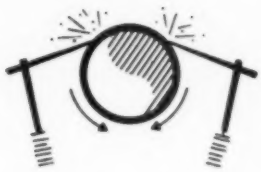
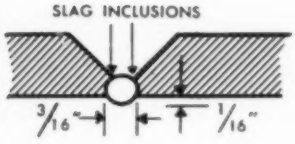
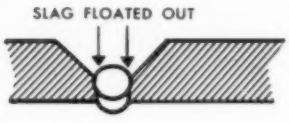
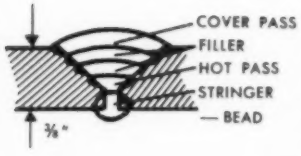
The sheer brawn and individual know-how of the old time spread man is being replaced by recognized engineering practices, accurate aerial and ground surveys, scientific studies of terrain, soil and rock conditions, weather and water data as gathered by the Weather Bureau, and design conditions. Pipeline construction is controlled not only by individual specifications, but by recognized codes and standards.

Welding, as one of the prime functions, is served by a special standard design to produce the highest quality workmanship consistent with economic practices. This is the API Std 1104, Specification for Field Welding of Pipelines, and is used widely both in this country and in Europe and Asia. It covers all phases of welding and testing — both physical and nondestructive. Since this standard might be considered the primer of pipeline construction, I would like to use this as a basis for our discussion.

Highlights of pipeline history


400 B C
Chinese piped gas through bamboo stalks to evaporate sea-water for salt.
1821
Hollow log pipeline was first in U.S. Laid to Fredonia, N. Y.
1884
Pittsburgh had 335 miles of distribution lines — 250 M Mcfd
1891
First high pressure line 120 miles from Greentown, Ind. to Chicago operated at 525 psi.
1900
Natural gas had been discovered in 17 states. Production valued at $25 million
1911
First Oxy-Acetylene Welder!
1922
First Electric Welding on pipeline at Caney, Kansas. "Leaked like a sieve."
1926
DAILY NEWS
170 mile 22 in. line completed to Baton Rouge.
1944
1958
Following WW II Pipeline construction zoomed.

Pipeline field Welding today

Electrodes used		E6010 — for stringer bead and cover pass E7010 — for hot pass and filler passes
Method		Downhill — High arc amperage; high speed — yet high quality
Line-up and gap		Gap may be thickness of dime or nickel. Improved line-up clamps round out pipe. No tack welds today — instead stringer bead
Step welding for stringer beads on big inch pipe		If two welders making stringer beads, they weld 1 & 2, 3 & 4, 5 & 6 simultaneously. This maintains alignment and gap. Usually work in groups of two or four. Speed: 20-30 in. per minute for each stringer bead welder.
More about stringer bead		Welders drag rod on stringer bead. Internal finish is usually quite uniform.
Hot pass		Hot pass burns out most slag inclusions (wagon tracks) of stringer bead, repairs windows.
How many passes?		Typical weld: One pass for each ⅛-in. thickness of pipe plus stringer and cover pass. ⅜ wt pipe — 5 passes.
Factors other than welders skill that affect quality		Wire brush, ice pick disc grinder. Thorough cleaning between passes. Welding generator. Condition and quality of welding machine affects welds.
What's new		Low hydrogen and iron powder contact electrodes for downhand welding. Should be useful for sleeves, saddles, etc.

Continued

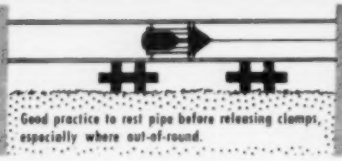
More about line-up

Out-of-roundness at pipe mill almost inexcusable.

During shipment, pipe may be slightly bent, but new internal line-up clamps can round it out.

CAUTION — Major rounding out in field where a permanent set cannot be achieved can produce locked-up stresses in stringer. This plus normal welding stresses can cause root bead cracks during second pass when strength of stringer is reduced by heat momentarily.

Releasing line-up clamps



Good practice to rest pipe before releasing clamps, especially where out-of-round.

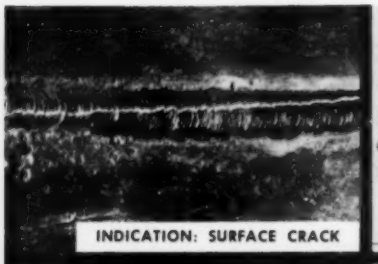
Steel in pipe has comparatively little strength until cooled below brittle stage at about 600 F. Spring-back, plus bending stress in construction can cause underbead cracking unless steel has passed through this critical temperature.

Non Destructive Testing

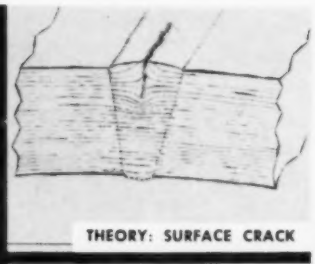
Magnetic Inspection

It is faster, easier to apply than radiographic inspection, but it is not so thorough.

The latest development — a magnetic inspection record can be preserved by an adhesive belt which transfers the flux powder for a permanent record similar to photographic film.

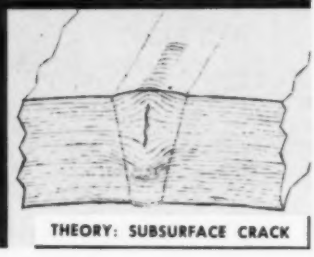


INDICATION: SURFACE CRACK



THEORY: SURFACE CRACK

INDICATION: SUBSURFACE DEFECT

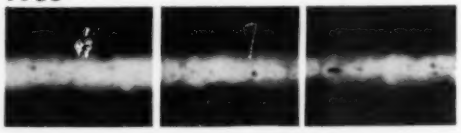


THEORY: SUBSURFACE CRACK

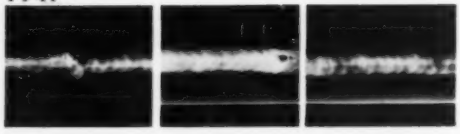
Radiography

Technique of radiography is improving and so is welding. Before it was developed one company experienced about one leak per mile on newly constructed line. But when the same company used radiography for inspection of 25% of its welds on a 1400-mi line, there were only six leaks.

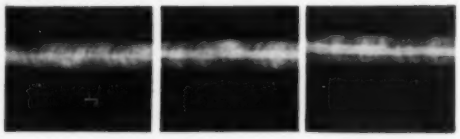
1930



1947



1957



Dye Penetrants

Dye penetrants have been used in all types inspection. Because of simplicity of application and rapid production of results this method is frequently used in conjunction with repair and welding to locate surface defects or to determine if defects have been completely removed by chipping and grinding.

Ultrasonic Inspection

Ultrasonic inspection is finding more and more uses, but it is not developed yet for full cross-country pipeline inspection.

However, it does have an advantage in determination of pipe wall soundness and pipe wall thickness for installation of taps and other welding on lines in service. It will show laminations and dangerous conditions that might deter welding.

New Developments

Low alloy steels of high strength are in the planning stage — we can expect such steel with 100,000 psi tensile strength before long.

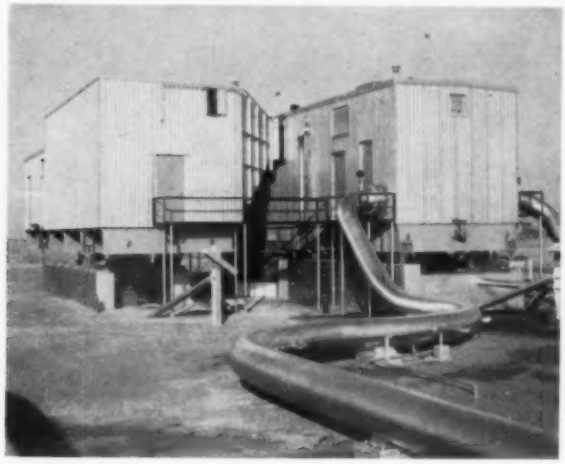
Materials having high corrosion resistance are needed for transportation of corrosive materials. Stainless clad steel may offer some advantages. Plastic pipe or plastic linings may also become popular.

New welding processes and new types of electrodes will come. Automatic welding also will be used.

More stringent quality control methods will be developed.

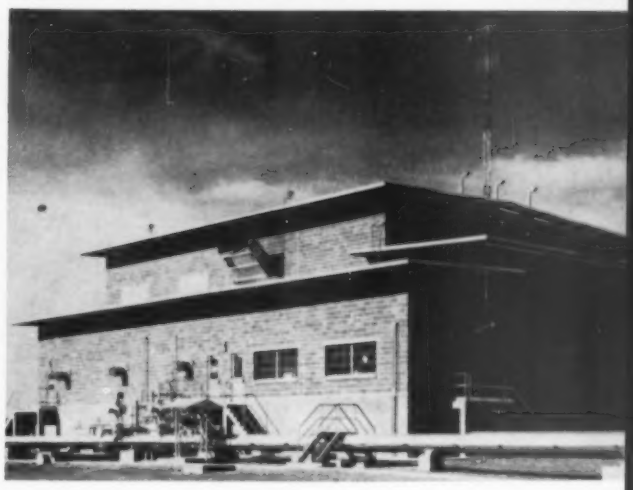
Portable Turbine Station

There are four portable vans at each station; the two here are control van (left) and turbine van (right).



Permanent Turbine Station

Turbine units permanently mounted in pump house at Qaryatain, Jordan, are operated remotely.



Crude-burning Turbines up tapline throughput

By **W. E. Locher,** *Manager Operations, Tapline, Beirut, Lebanon*
A. E. Olson, *Chief Engineer, Tapline, Beirut, Lebanon*
P. P. Nibley, *Manager Operations, Tapline, New York*

The Trans-Arabian Pipe Line Company has six new pumping units driven by 5000-hp General Electric combustion gas turbines that are providing the power to increase the throughput of the 754-mile, 30 and 31-in. Tapline system from 320,000 to 450,000 bbl of crude oil per day.

The crude-burning gas turbine pumping units are of two types: (a) Portable prefabricated units for unattended operation at intermediate sites. (b) Permanently installed units at existing stations.

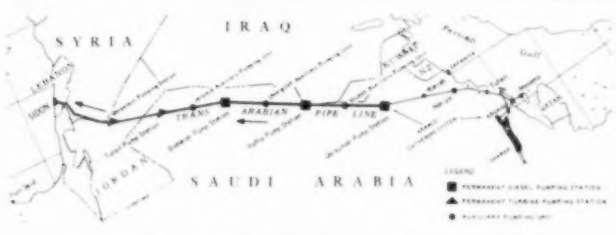
Original system. The original Tapline system had four diesel-engine pump stations about 160 miles apart. Each one is a complete community with housing for 80 to 250 employees, hospitals, warehouses, etc.

Present expanded system. Added to the original Tapline system were: (a) Three portable turbine pumping units in Saudi Arabia. (b) A permanently mounted turbine unit at an existing maintenance base in Jordan. (c) Two permanently mounted turbine units which replace diesel-driven pumping units at the Turaif pump station. (d) The replaced diesel units are being relocated at existing diesel stations.

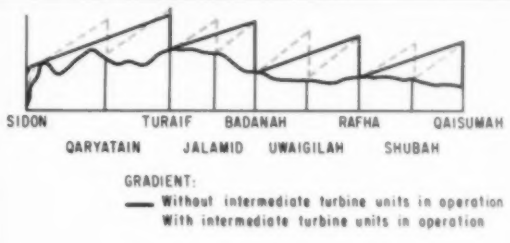
In addition Aramco has installed two portable turbine units on its 270-mile gathering line at Wariah and Turaif. An identical unit is available as a stand-by for the five portable operating units.

Total cost for this expansion was about twenty-one million dollars.

Design considerations. Originally Tapline was designed for four additional pump stations at intermediate locations. However, the large investment and high operating costs of complete community-type stations made expansion uneconomical. The most attractive scheme to increase capacity was to add one 5000-hp unattended pumping unit at each intermediate location, and the combustion turbine was the only prime mover which satisfied the design requirements which were: (a) 5000-hp output for continuous operation at 110 F ambient temperature and 2600-ft elevation. (b) A



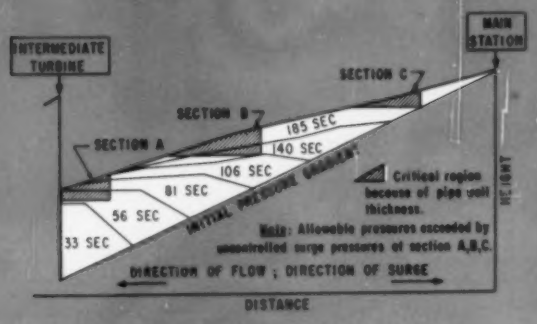
The Trans-Arabian Pipe Line System



PROFILE AND HYDRAULIC GRADIENT

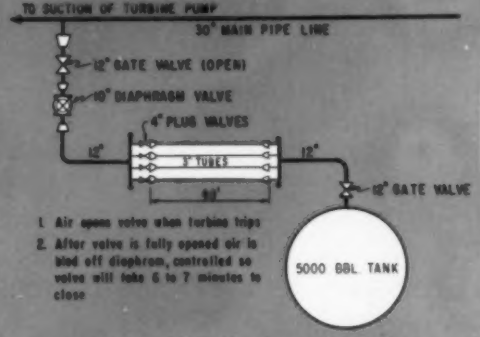
GE

Big surges come when big units trip off.



PREDICTED PRESSURE DISTRIBUTION FOR UNCONTROLLED SURGES WHEN TURBINE UNIT TRIPS OFF

But pressure relief system protects line.


TO SUCTION OF TURBINE PUMP
30" MAIN PIPE LINE
12" GATE VALVE (OPEN)
10" DIAPHRAGM VALVE
4" PLUG VALVES
3" TUBES
12" GATE VALVE
1. Air opens valve when turbine trips
2. After valve is fully opened air in blad off diaphram, controlled so valve will take 6 to 7 minutes to close
5000 BBL TANK

SURGE PRESSURE RELIEF SYSTEM - QARYATAIN

prime mover fueled with crude oil from the line. (c) A unit to be suitable for unattended operation with supervisory control from base stations 50 to 100 miles away. (d) Unit to be portable to permit rotation and major overhauls at a central shop.

The International General Electric Company supplied the permanently mounted turbines for the main stations and the auxiliary units which were prefabricated and tested in the U. S., then shipped to the job sites, slid onto prepared foundations and connected to pump oil. Virtually all the work was completed by March 1, 1958.

Firsts. This is the first time a main line oil pump has been driven directly at gas turbine speeds (the range is 5000 to 6000 rpm). These are the first complete 5000-hp pumping units to be prefabricated and made wholly portable.

Hydraulics and pressure surges

The line operates as an open system with a tank on the incoming line at each main station. In a hydraulic sense this isolates the sections of the line between main stations, making it easier to bring the intermediate gas-turbine-driven pumps onstream, since each one affects only the pressures in one section.

Surge problems. In the original system, a 96,000-bbl floating roof tank connected to the suction of each station provided protection against surges whenever a station shut down.

But the gas turbine pumping units were added without any provision for tankage, and obviously when one of these units trips off, a high-pressure surge would travel upstream toward the main station and in certain critical regions could exceed the allowable pipeline pressures. To minimize this effect, Tapline installed surge-protection equipment shown in the illustrations. Note the lines marked 33 sec, 56 sec, etc., which show the probable progress of an uncontrolled pressure surge traveling upstream when a unit is tripped off. Obviously, all three critical sections, A, B, and C, would be over-pressured by the surge.

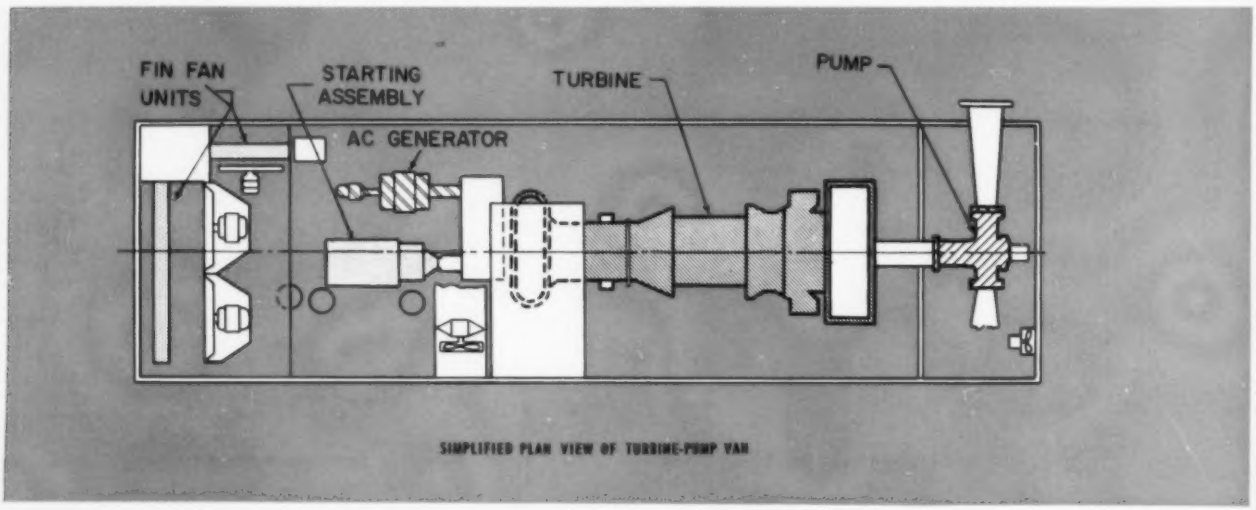
Critical sections B and C occur downstream from all four main stations, and those can be protected by quickly reducing the main station pressure. Normally, VHF radio takes care of this. However, the signal ceases when the unit trips, and the main station pressure is automatically reduced by de-energizing a circuit which reduces the discharge pressure.

A relief system installed at Qaryatain is shown in the illustration.

Portable auxiliary pumping units

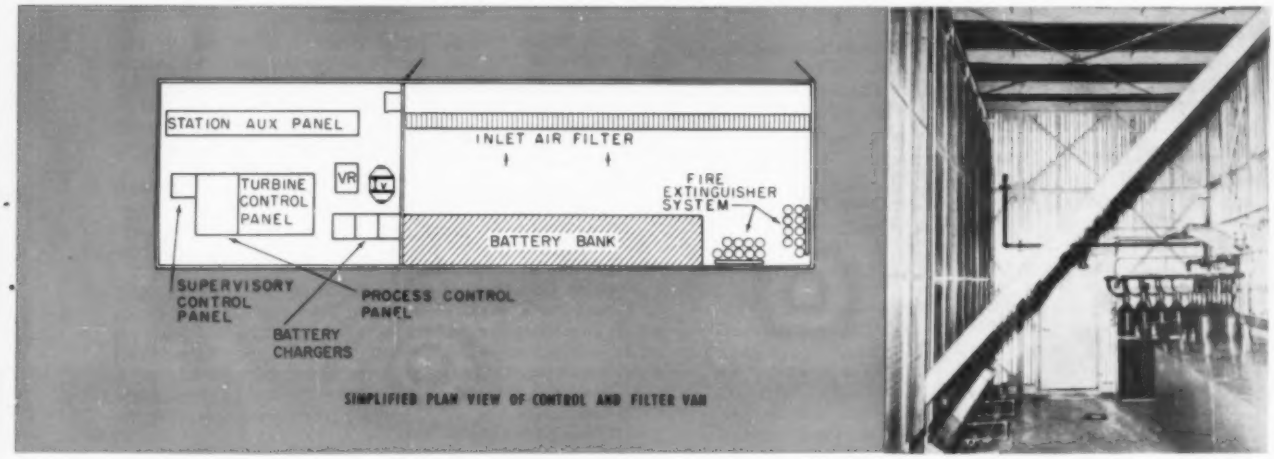
These installations consist of four portable vans each: (a) Turbine-pump van. (b) Control and filter van. (c) Radio van (with 200 ft high antenna tower permanently erected close-by). (d) Portable shop van.

The turbine-pump van is about 53 by 15 ft, and 18 ft high. It has two rooms, one for the turbine and the other



SIMPLIFIED PLAN VIEW OF TURBINE-PUMP VAN

Inside control and filter van. Traveling screen filters at left; fire extinguisher system and batteries at right.



SIMPLIFIED PLAN VIEW OF CONTROL AND FILTER VAN

for the pump. There is a fire wall between them, and the turbine side is pressurized.

Because the 5000 hp, two-shaft unit burns crude from the line which contains about 10 ppm of vanadium it requires addition of 0.03 percent by weight of hydrous magnesium sulfate to minimize corrosion of the turbine blades.

The turbine is started by a 200-hp diesel engine with torque converter drive. The engine operates through a jaw-type clutch which automatically disengages.

The main crude oil pump was manufactured by Byron Jackson Pumps, Inc. It is extremely compact and light, weighing less than 0.8 lb per bhp. It delivers more than 600 psi differential with a single-stage impeller.

The temperature of the lube oil cooling water is automatically maintained by two fin-fan units driven by two 20-hp motors. During cool-down an auxiliary 5-hp d-c fin-fan cooler is used. The van including all equipment weighs about 125 tons.

The control and filter van is open on top to admit air through the filter for the turbine and for ventilation of the turbine and control rooms. The air filter is a traveling-screen type with an oil bath reservoir at its base.

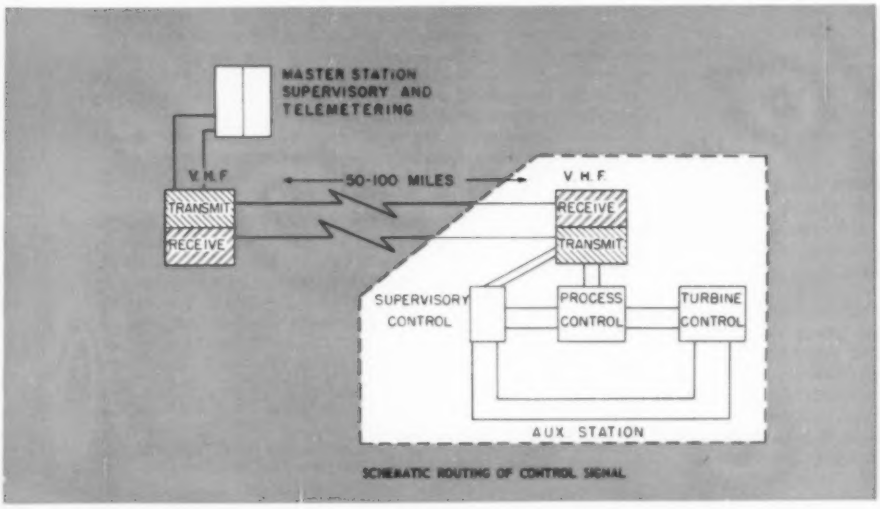
The control room portion of the van has a slight positive air pressure to exclude dust and petroleum vapors from the electrical switchgears, starters and relays. This room also houses the turbine control panel, process control panel, remote supervisory control panel, the voltage regulator, battery charger, and a 10-kva inverter. The latter supplies constant-frequency a-c power to some of the instruments and the communication system. Van weight is about 84 tons.

The radio van houses the VHF radio and a 30-kw auxiliary diesel-generator set. There are three 250-watt, 150-megacycle, FM transmitters in each van; two are for voice, telemetering, and supervisory equipment; the third is for communication with mobile equipment. The system employs scatter propagation and utilizes extremely high gain antenna arrays mounted on 200-ft-high towers.

When the turbine shuts down, the auxiliary generator automatically supplies power to the 208-volt bus to maintain lights, communication, etc., and a charge on the 800-ampere-hour battery bank. If the auxiliary generator is out of service, the station battery, fully charged, is capable of supplying electric power for three start-ups of the turbine. The battery also supplies power to maintain communications for a preselected period of up to one hour. Information transmitted during this period is the basis for making decisions on whether to re-start the unit by remote control or whether to dispatch maintenance personnel.

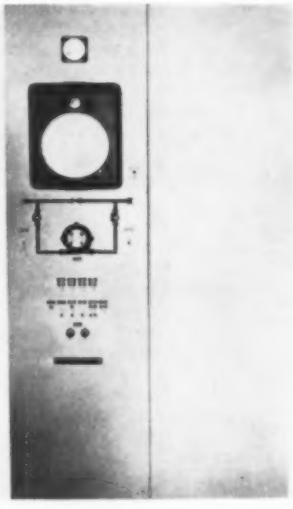
The portable shop van houses a shop and parts storage area as well as personnel lockers, an electric kitchen and a wash room.

Description of control system. The master supervisory control panel is located 50 to 100 miles from the operating unit at one of the permanent pump stations. It is an all-relay, space code selector system, which provides the means for



SCHEMATIC ROUTING OF CONTROL SIGNAL

Master supervisory panel.



starting and stopping the turbine, for changing discharge pressure, and for receiving alarms.

In addition, ambient temperature, discharge and suction pressure and the discharge pressure set point are telemetered continuously. This information is carried simultaneously on two independent VHF circuits to avoid an interruption of contact.

Details of control panels

Alarm system. For transmission to the master station, indications of malfunction are segregated into *First Order, Second Order and Third Order alarms.* The operator at the master station receives an indication of the group to which the malfunction belongs but is not informed as to the precise nature of the malfunction.

First Order alarms and trips include over-speed, low lube oil pressure, excessive vibration, and fire. The unit trips off for any malfunction in this group. A maintenance man is dispatched to the unit and no effort is made to re-start it remotely until the fault has been located and corrected.

Second Order alarms and trips involve less serious malfunctions such as failure of starting clutch to engage, loss of flame and low battery voltage. When the master station receives this indication, a maintenance man is dispatched to the unit, but meanwhile the operator will attempt to start the unit if it has tripped off.

Third Order alarms and trips involve high discharge pressure, low suction pressure and high case temperature on the main line pump. On receiving this indication the unit is restarted or continues to operate. A maintenance man checks the malfunction on his next routine visit to the unit.

Remote control. When the operator at the master supervisory control depresses the "start" selector key, the turbine control panel sends a signal to the motor starter panel to start the d-c motors of the auxiliary fans and pumps required for commencing operations. The main line gate valves also open, pressurizing the main crude oil pump.

After a five-minute purging of the turbine van by the d-c purge fan, the starting diesel engine starts, the clutch engages and the turbine is accelerated to firing speed. After firing, the turbine is accelerated to idling speed. During the latter, the 125 kw a-c generator starts, and the a-c station motors are started in pre-set sequence as the d-c motors shut down. After that, a signal is sent back to the master control panel, indicating that the starting sequence has been completed. The discharge pressure set point is controlled by the operator.

The turbine control panel. The left side contains a vibration recorder and two temperature recorders. The right side contains the turbine control equipment, at the top are shaft speed indicators, second-stage nozzle position indicator, and fired hours timer. There is also a 36-point annunciator panel, signal lights and selector switches for starting, stopping, and operating the turbine locally.

The process control panel. This system basically compares a pneumatic pressure established by a transmitter with an established pneumatic pressure which is a function of the desired process pressure (set point). If there is a difference in these readings, an "error" signal is sent to the turbine control to increase or decrease turbine speed accordingly.

There are over-riding controls which limit the rate of change of pressure, the minimum suction and maximum discharge pressure.

Description of permanent pumping units

The turbine unit and control system are almost identical to those in the auxiliary pumping units. The pumphouse is operated on an unattended basis. The pumping unit is controlled from the nearest main station more than 100 miles away.

Unique suction booster pumps. The installation of two 5000-hp turbine units at the permanent pump station at Turaif, Saudi Arabia, features a unique suction booster pump. When both turbines are operating, an excess of hydraulic horsepower is utilized to operate a hydraulic turbine-driven booster pump, to provide a suction pressure of 60 to 90 psig for the main pumps. This requires that part of the station discharge be bled back to suction through a hydraulic turbine. This unique unit has eliminated the need for supplementary generator capacity.

Operation and maintenance

Up to March 1, 1958, Aramco and Tapline had successfully operated the gas turbine pumping units for about 12,000 hours. Most of this time personnel were in attendance to take care of possible emergencies or to record operating data. However, one of the units has had several months of unattended operation, with an availability factor of better than 90 percent.

Initial design premises were based on estimates that, with an additional 180,000-bbl tank at each main station, an operating factor of 80 percent would be realistic. However, experience to date has pointed the way to significant improvements in this operating factor.

Turbine Overhaul. Two of the auxiliary pumping unit turbines have been disassembled at their regular locations in order to make adjustments to main bearings and seals. A crane was moved to the turbine van and, after roof-sections were removed, turbine parts were lifted out and laid on a canvas on the ground. Adjustments were made and those parts which required machine shop work were moved to the central machine shop at Turaif.

Tapline plans to move each turbine van to the central shop at Turaif for major overhauls. During these occasions the spare turbine van will be installed for temporary operation at the intermediate location.

Minor maintenance. Some of the troubles which have been encountered are: (a) **Fuel pump failure** caused by sticking of the plungers. The longest continuous operation of a fuel pump to date is 1700 hours. Lubrication with the crude oil used for combustion appears to be the solution to this problem. (b) **Several sets of seals were scored by foreign material** which probably had been lying dormant in the pipeline until picked up when the flow rates increased. Properly designed knockout pots should eliminate this problem. (c) **Failures of combustion cone clips.** The supplier has corrected the difficulty. (d) **Recirculation of exhaust gases and lube oil vent vapors,** sucked into the compressor intake cause fouling of the compressor blades with an oily carbon deposit. To minimize this problem, the exhaust stacks have been extended, and the lube oil vents piped alongside the stack extension.

No special troubles have been encountered with the electrical system.

Operating Performance. The high-speed main line pumps are now operating with a suction pressure as low as 60 psig. A slight cavitation begins at 28 psig at 18,000 bbl per hour flow rate — a much lower pressure than had been anticipated.

With the ambient air temperatures (30 F to 110 F) encountered along the pipeline, turbine power is expected to range from 5000 to 8000 bhp. It should average about 6000 bhp over the course of a year.

Future application. The unattended turbine pumping unit is extremely attractive from the standpoint of low investment per horsepower. The installed cost of an unattended auxiliary pumping unit, including the communication, etc., is about $1,500,000, or $250 per bhp on the basis of an expected annual average output of 6000 bhp. **This is one sixth the investment per horsepower of a conventional community-type pumping station in Saudi Arabia.**

Preliminary operating experience indicates a high degree of reliability and a relatively low operating cost despite a fuel consumption per horsepower hour almost twice that of the originally installed diesel engines.

The feasibility of unattended gas turbine pumping units definitely changes the economics of pump station spacing for large diameter pipelines in the Middle East. Because of the lower investment per horsepower, the optimum spacing for unattended pumping units will be much closer for a given pipe size than for the older, extremely expensive stations of the community type.

References

"Intermediate Gas Turbine Pumping Units of Trans-Arabian Pipe Line Company" by P. P. Nibley and A. Y. Hillman, Jr., *Electrical Engineering*, Vol. 77, No. 2, February 1958.

"Gas Turbines in the Arabian Desert" by W. E. Locher, A. E. Olson, and P. P. Nibley, presented at ASME Gas Turbine Conference, Washington, D. C., March 3, 1958. (ASME Paper No. 58-GTP-8.)

This paper was presented at the API, Division of Transportation meeting, New Orleans, Louisiana, April 1, 1958.

Why automatic custody transfer is growing

By H. L. Shatto, *Senior Mechanical Engineer, Shell Oil Company*
and A. H. Hall, *Technical Specialist, Shell Pipe Line Corporation*

The use of automatic custody transfer equipment is growing rapidly after a rather long period of development, and many of the installations have paid off handsomely to the producers through saving the price of new tankage which would otherwise have been required. Yet, the surface has only been touched, and widespread growth seemingly lies ahead.

Producers are currently making these installations only at those locations where it is to their benefit: On leases with fairly high production where new tankage is required. So far, these scattered applications have netted little savings to the pipelines. Further development on this basis alone will restrict the areas of profitable application of ACT equipment to the producers and will continue to give little benefit to pipeline companies.

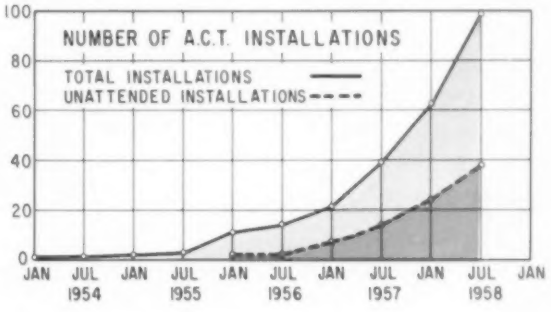
Economic studies indicate that ACT equipment has almost unlimited potential application that can net good returns to the industry. Needed is leadership and initiative from both pipeline and producing companies.

The rapid growth in recent years is reflected in the accompanying data and curves that are the result of a questionnaire believed to cover nearly all of the ACT facilities now in operation, under test, or under construction. The data given cover a total of 99 installations, all of which should be in operation by July 1958, and involve 18 producing companies, 29 pipeline companies, and locations in 12 states and two provinces of Canada.

How ACT installations are spurting ahead

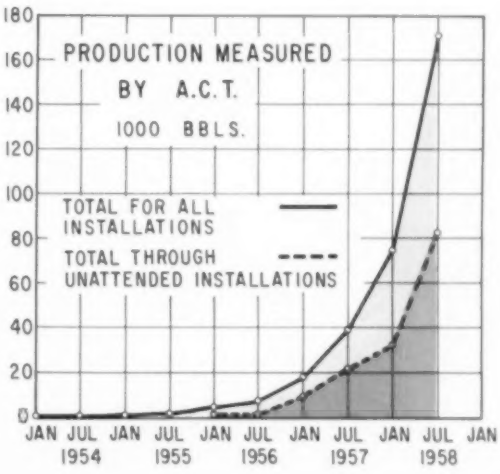
Experimental work was begun on an ACT system utilizing tanks by Shell Oil in the Antelope field of North Texas early in 1948. Imperial Oil Company placed the first unattended system in operation during November 1955 in the Redwater field in Canada, using positive displacement meters for measurement. In the U. S., the first unattended ACT installation was a tank system placed in operation by Gulf Oil in Bloomer, Kansas, December 1955.

The total number of ACT installations has almost tripled each year since 1954. Approximately 40 percent of the installations are in unattended operation. The difference between the number attended and unattended is due principally to the lag between construction of an installation and the beginning of unattended operations.



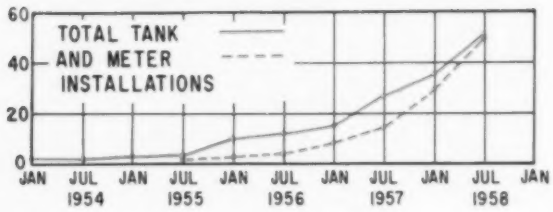
About 2½ percent of U. S. and Canadian crude is now handled by ACT

The total throughput for the 99 systems covered in this survey amounts to 170,000 bbl per day, and about half of this total is — or will be by the middle of 1958 — handled by unattended facilities. The production to be measured by all ACT installations completed by July 1958 amounts to less than 2.5 percent of the production in the United States and Canada, and less than 1.2 percent of this production will be in unattended operation by midyear. These percentages are not significant in themselves, but if the past rate of growth continues, and there is every reason to believe that it will, a significant share of total production should be in unattended ACT operation within a few years.



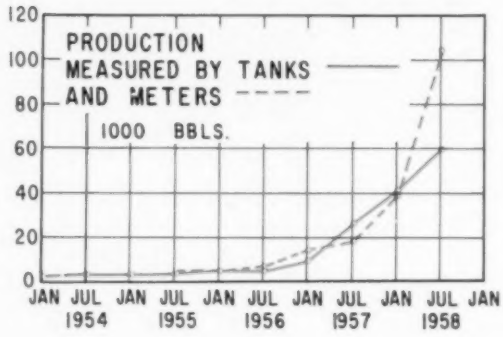
ACT Measurements: Tanks vs positive displacement meters

The top curves show the comparative growth of meter systems and tank systems. For over two years tank systems have held a substantial lead; however, by mid-year 1958 there should be approximately as many meter systems in operation as there are tank systems. The total throughput for meter systems will have jumped sharply upward to almost twice the throughput for tank systems by mid-year as shown in the lower curves.



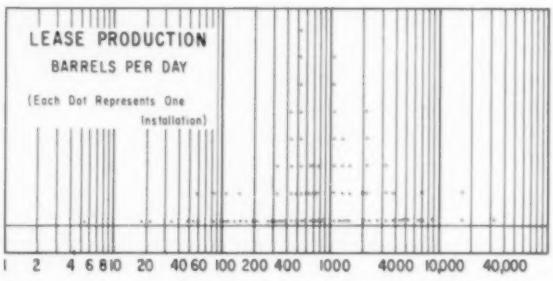
What size ACT installations?

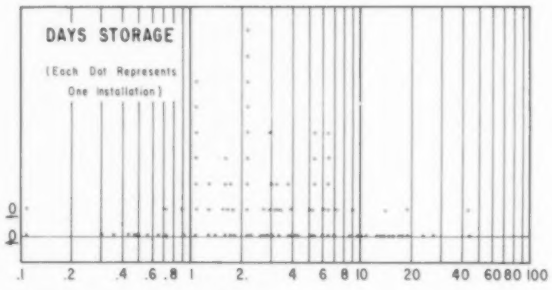
The throughput capacities range from 5 to 30,000 bbl per day. Each of the dots indicate one ACT installation. The largest grouping appears to be in the 500 to 1000-bbl-per-day. Each of the dots indicate one ACT installation. The easily justified in leases having somewhat higher-than-average production. Several of the points shown below the throughput of 100 bbl per day are known to have been justified on the basis of completely automatizing given areas in order to permit real labor savings to be made.



How many days storage in each system?

The distribution of emergency storage capacity used with the 99 systems covered in this survey is shown here. In many cases it was noted that the manually-operated conventional storage had not yet been removed. It is believed safe to assume that those installations which have, say, about three or more days' storage fall into this category. It is particularly interesting to note the number of installations which have emergency storage capacity ranging below one-third of a day and even down to zero in two cases.


LEASE PRODUCTION
BARRELS PER DAY
(Each Dot Represents One Installation)
1 2 4 6 8 10 20 40 60 100 200 400 1000 4000 10,000 40,000



Difficulties with ACT systems

Two installations were reported unsatisfactory, but only for minor difficulties, believed to be subject to easy correction. Some difficulties with positive displacement meters were reported: One was a steady drift of meter factor which had not yet been explained. It was presumed to be caused by meter wear or incrustation in the meter prover tank. Some malfunction of the level sensing devices in tanks was reported. In a few cases, minor difficulties have been found in sampling. In those unattended installations where run tickets are produced only once a month, the operators were asked whether the pipeline gager found it necessary to make inspection trips between his scheduled visits. It was encouraging to note that there has not been such a need.

Summed up, ACT installations have been widely scattered and generally applied to leases having somewhat higher than average production. Moreover, the operational use of ACT equipment is growing at such a high rate that immediate consideration by every producing and pipeline company is certainly justified.

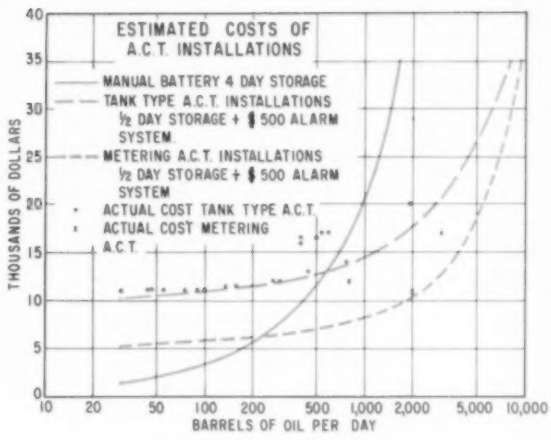
How are the ACT systems equipped?

Dielectric BS&W monitors (3 to 1 non-recording)	90%
Diverting of non-merchantable oil to treating	60%
Diverting non-merchantable oil to storage	22%
Shutdown in event of malfunction	66%
Equipped with a pipeline pump	60%
Pipeline pump required for manual operation	46%
Allowable stop valves for scheduling	60%
Time clocks for scheduling production	40%
Oil heat-treating facilities	86%
Electrically operated controls	91%
Pneumatic controls (assumed)	9%
Installations using meters	49%
Metered installations having only one meter	61%
Metered installations having meters in series	10%
Metered installations having meters in parallel	29%
Meters with temperature compensation	98%
Meters with ticket printers	92%
Metered installations with meter charging pumps	74%
Metered systems having air eliminators	65%
Metered systems having strainers	79%

Meter proving . . 51% by prover tank; 31% by stock tank; 16% by master meter; 2% by gravimetric means.

Estimated costs of ACT installations

The composite cost curves shown here have been prepared for various throughput rates for meter ACT systems, tank ACT systems, and conventional manually gaged tankage. The curve for manual tankage is based on four days' storage, and the curves for ACT batteries include one-half day's storage plus $500 for an alarm or shut-down system. The estimated curves for the ACT systems are felt to represent realistic minimum costs for good and complete systems. A number of points representing actual costs are shown and, in order to permit comparison, these costs have also been adjusted to include one-half day's emergency storage. Some of the actual cost figures are considerably higher above the curves for several reasons. In some cases, lower cost equipment is now available to the same job; in others, the installations were experimental and little attention was paid to cost; in still others, every possible feature was added to insure successful operation.



ACT costs and savings

On new installations, savings come from the differences in cost between an ACT system and a manual battery. The break-even point for tank ACT systems is about 600 bbl per day and for meter systems at 250 bbl per day.

Evaporation losses. By manual gaging methods, these losses are generally agreed to be approximately 0.2 deg API gravity and 0.5 percent in volume.

Estimates of **labor savings** to the producer have ranged from zero to $200 per month per lease.

The justification for ACT is clear where tankage cost is highest. But many leases have production less than the break-even point, and on these the producer's only significant source of return for the added cost for ACT lies in the savings of evaporation loss. As shown here this is not enough to justify the smaller systems.

	50 BOPD	100 BOPD	200 BOPD
Cost of meter ACT installation including one day's storage	$5,500	$6,000	$6,500
Manual battery with four days' storage	two 100-bbl tanks $2,000	two 200-bbl tanks $3,000	four 200-bbl tanks $6,000
Direct additional cost for ACT	$3,500	$3,000	$ 500
Savings to pipeline by connecting, strapping, calculating tank tables, etc., for one tank instead of two or more tanks	100	100	300
Total net additional cost for ACT	$3,400	$2,900	$ 200
Savings to pipeline by making one run ticket per month rather than one per tank, assuming a cost of 15/run ticket and deducting 110/mo for meter proving	$60/mo.	$60/mo.	$135/mo.
Value of vapor savings to producer assuming 0.2 API gravity increase —0.5% volume increase	$20/mo.	$40/mo.	$80/mo.
Payout from producer savings alone on direct additional cost	14.6 yr.	6.2 yr.	0.5 yr.
Payout from total pipeline and producer savings on total net cost	3.5 yr.	2.4 yr.	0.1 yr.

Why pipelines should push ACT

First, the savings in operation from widespread adoption would be great. Without initiative, pipelines are not in position to influence a sufficient quantity of installations to benefit greatest from the economies.

Second, pipelines need to maintain a good control over measurement accuracy. This can best be done if pipelines establish policies which lead and encourage ACT installations.

Pipeline ACT policy

One pipeline company has drawn up such a policy, using the API Bulletin 2509-A as a source of basic information. Summed up here are the highlights of this company's policy:

General. When permitted by law and regulations, the pipeline will receive crude on the basis of unattended custody transfer measurement so long as it is satisfied as to the accuracy.

Design, construction and cost is the responsibility of the producer, but the installation must conform to the applicable API codes and standards. Where fluid is started and stopped automatically, there must be separate control panels so measurements to the pipeline can be sealed.

Volume measurement must be consistently within 1/10 of 1 percent.

Temperature measurements. Positive displacement meters must be temperature compensated; temperature recorders must be installed for tank measurement.

Mechanical samplers. Where used, sample must be representative of the stream.

Merchantable liquid. Must have a dielectric instrument that will automatically stop off-specification liquids.

Vapor pressure and liquid stability. The measured liquid must have sufficient head, so losses will be within limits accepted by the industry.

Pumping equipment usually installed by the pipeline. But auxiliary pumping to supply head to ACT unit will be at the expense of the owner.

Calibration and maintenance. Normally pipeline will supply portable meter prover. Unusual tanks, etc., to be furnished by operator. Same for high pressures to return fluid to the line from the prover tank. In most cases the pipeline will assume responsibility for periodic calibration, will maintain instruments and meters at actual cost to the owner.

Acknowledgment. This is a digest of a paper presented at the API's Division of Transportation Annual Pipeline Conference in New Orleans, March 31 to April 2, 1958.

When to Replace a Tractor?

This is the METRE Method. METRE stands for, "Most Economical Time to Replace Equipment," and it will work on other equipment

by Gene Evancoe, *Caterpillar Americas Company, Calgary, Alberta, Canada*

This method can assist equipment owners in arriving at a sound decision as to when to replace used machinery. Trading too soon is costly, but so is not trading soon enough. There's an optimum time to replace — the question is how to find it. Several factors must be considered. First, comes records. Sound bidding depends on them. A contractor must know his equipment owning and operating costs.

The METRE Method depends on four points to arrive at the economic time to replace equipment. They are: (1) *Major Repair and Overhaul Costs,* (2) *Productivity,* (3) *Availability* (lost time), and (4) *Capital Decline.* To use this method, dollar values must be assigned to all four factors.

First, consider major overhauls and repairs. In determining the hourly costs of this item, the costs should not be charged until they occur. No back charging. This is logical, because repairs are made in order to do future work, and for our purposes they last until new ones are made.

Let's take a typical example, "Tractor X." The first engine overhaul came at the end of 6000 hours which is in the fourth year of work (tractors operate about 1800 hours per year for the first three years; 1500 hours per year afterward). The cost should be allocated to the subsequent period between overhauls—in this instance the 4th, 5th, 6th and 7th years of operation. Remember, cost per hour equals the cost of repairs divided by the number of hours operated before subsequent repairs. Now let's take a look at . . .

Example: 'Tractor X'

Its cost, repair requirements, etc.

ORIGINAL COST (equipped with dozer and control)	$20,000
Rental value	$10/hr
Conditions	Average
Horsepower	100

LIFE BETWEEN OVERHAULS:

Engine	6,000 hr
Steering clutch	5,000 "
Brakes	500 "
Tracks	3,000 "
Cable control	3,000 "
Roller frame & sprocket group	5,000 "
Master clutch (oil type)	10,000 "
End bits and cutting edges	1,000 "
Transmissions & final drives	6,000 "
Guards, hoods and fenders	3,000 "

HOURS OPERATED:

First, second and third years—each	1,800 "
Each year thereafter	1,500 "

Cost of its major repairs and overhauls

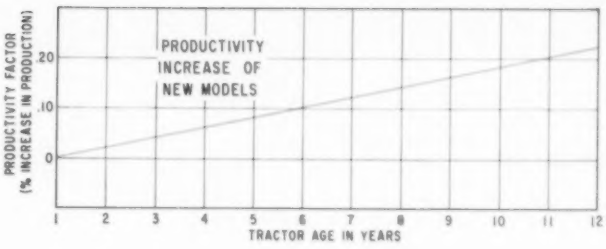
Component	Overhaul	Parts cost	Hours of labor	Cost of labor @$2.50	Total cost of repairs	Hours between overhaul	Cost per hour
Engine	1st	$ 488	104	$ 260	$ 748	6,000	.12
	2nd	1,050	126	315	1,365	6,000	.23
	3rd	1,520	112	300	1,820	6,000	.30
Steering clutch	Each	390	20	50	440	5,000	.09
Brakes	Each	17	7	17.50	34.50	500	.07
Tracks	New set	1,835	5.2	13	1,848	3,000	.62
Cable control	1st	71	8	20	91	3,000	.03
	2nd	178	14	35	213	3,000	.07
	3rd	147	14	35	182	3,000	.06
Roller frame & sprocket group	1st	1,782	44	110	1,892	5,000	.38
	2nd	2,315	57.4	143	2,458	5,000	.49
	3rd	2,610	64.5	161	2,771	5,000	.55
Oil type master clutch	Each	553	19.2	48	601	10,000	.06
End bits & cut. edges	Each	67	6	15	82	1,000	.08
Transmission &	1st	756	42	105	861	6,000	.14
final drives	2nd	1,603	55.4	138	1,741	6,000	.29
Guards, hoods,	1st	255	2	5	260	3,000	.09
fenders	2nd	529	6	15	544	3,000	.18

But tractors get more efficient every year. How do you figure this in?

Because of higher horsepowers, faster speeds, improved attachments, operator comforts, etc., new model tractors increase in productivity about 2 percent per year. But before you assign a dollar value to this factor consider whether or not increased productivity can be utilized. If the old tractor can keep pace with a crew — a new one can do no better, perhaps.

Here's the way to calculate it:

Year	Productivity factor (from curve)	Rental/Hr.	Cost/Hr.
1.....	0%.....	$10.00.....	0
2.....	2%.....	$10.00.....	$0.20
3.....	4%.....	$10.00.....	$0.40 etc.

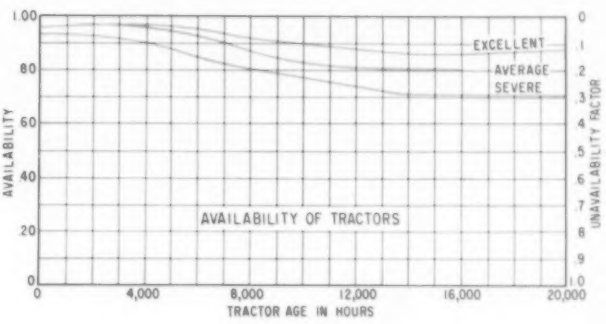


How about availability? Old tractors aren't on the line as much as new ones.

A new tractor is available for work only 96 percent of the time because of routine maintenance. Its unavailability factor is .04. Old ones level off at about 80 percent with an unavailability factor of .20. Cost factors are based upon making up the difference, so multiply the unavailability factors by the rental cost of $10 per hour.

Examples:

Year of operation	Hrs. logged at end of year	Unavailability factor from curve	Rental cost per hr	Cost per hr
1	1800	.04	$10.00	$ .40
2	3600	.05	10.00	.50
3	5400	.07	10.00	.70
4	6900	.11	10.00	1.10
5	8400	.14	10.00	1.40 etc.

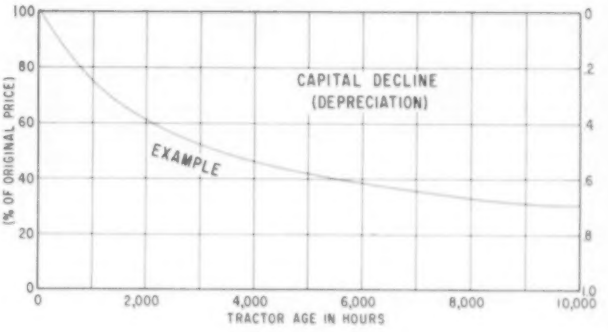


Now let's take investment depreciation, or capital decline.

Difference between the original cost and trade-in value is called "capital decline." It should be charged to the tractor in the year in which the decline occurs, not averaged throughout the life of the tractor. To calculate divide the annual decline by the number of hours worked. This curve was plotted from the sale of 2000 used machines of all makes, models and ages.

Example: Find the capital decline cost per hour for Tractor X that cost $20,000.

Year	Hours used per year	Hours at end of year	Capital decline factor	Total capital decline	Capital decline at end of previous year	Annual capital decline	Hourly cost
1	1800	1800	.38	$ 7,500	0	$7,600	4.22
2	1800	3600	.52	10,400	$ 7,500	2,800	1.55
3	1800	5400	.60	12,000	10,400	1,600	.89
4	1500	6900	.66	13,200	12,000	1,200	.80
5	1500	8400	.68	13,600	13,200	400	.27 etc.



When's the best time to trade "Tractor X?"

At the end of the third year when the hourly replacement cost is lowest (see the last line). It might appear that there's little difference between the third and fourth year — only $0.17 per hour for the long haul. But look at next to the last line and you'll see that the last year of operation actually costs $4.10 per hour to operate the tractor. Of course there are many variables in these calculations, and not among the least is the use to which the tractor is put.

	YEARS									
	1	2	3	4	5	6	7	8	9	10
Hours Operated Each Year	1800	1800	1800	1500	1500	1500	1500	1500	1500	1500
Total Hours at End of Year	1800	3600	5400	6900	8400	9900	11400	12900	14400	15900
Major Components	REPAIR AND OVERHAUL COST PER HOUR									
Engine	0	0	0	0.08	0.12	0.12	0.12	0.12	0.12	0.12
Steering Clutches	0	0	0.02	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Brakes	0.05	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Tracks	0	0.20	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Cable Control	0	0.01	0.03	0.05	0.07	0.06	0.06	0.06	0.06	0.06
Roller Frame & Sprocket Group	0	0	0.09	0.38	0.38	0.38	0.49	0.49	0.49	0.51
Master Clutch (all type)	0	0	0	0	0	0	0.05	0.05	0.06	0.05
End Bits & Cutting Edges	0.04	0.08	0.08	0.08	0.03	0.09	0.08	0.08	0.08	0.03
Transmission & Final Drives	0	0	0	0.09	0.14	0.14	0.14	0.20	0.29	0.29
Guards, Hoods, Fenders	0	0.03	0.09	0.14	0.18	0.18	0.18	0.18	0.18	0.18
Total Repair & Overhaul Cost Hr.	0.09	0.39	0.99	1.60	1.75	1.74	1.91	1.97	2.06	2.08
Productivity Cost Per Hour	0.00	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80
Unavailability Cost Per Hour	0.40	0.50	0.70	1.10	1.40	1.70	1.80	1.90	2.00	2.00
Capital Decline Cost Per Hour	4.22	1.55	0.80	0.80	0.27	0.27	0	0	0	0
Total Cost Per Hour*	4.71	2.64	2.98	4.10	4.22	4.71	4.91	5.27	5.66	5.88
Average Hourly Cost if Tractor is Replaced at End of Given Year	4.71	3.68	3.44	3.61	3.73	3.89	4.04	4.19	4.36	4.51

* Excluding operator fuel, grease, etc.

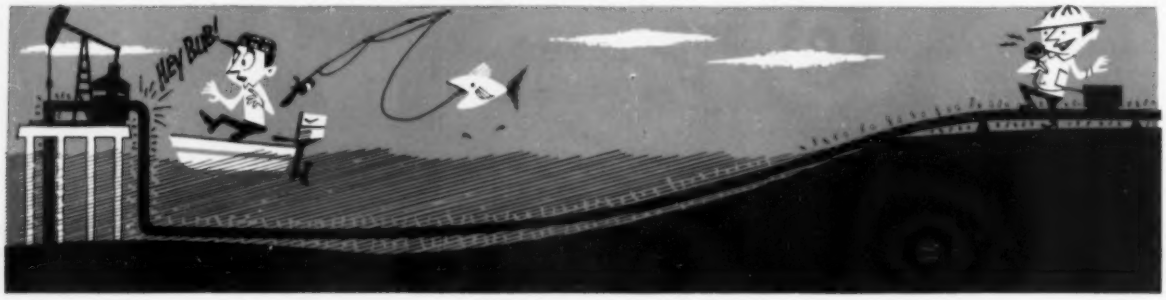
Editor's note:

This GRAPHIC ENGINEERING DIGEST was prepared from a paper presented before the annual convention of the Pipe Line Contractor's Association of Canada, meeting Feb. 19 to 22 in Victoria, B. C., by Donald M. Taylor, Gulf Coast Editor. ★ ★ ★

DEVELOPMENTS TO WATCH

from the field and laboratory

Use the Pipeline as a Conductor for Communications?



They're doing it now, . . . experimentally! The pipeliner's fourth beer dream of using a pipeline as a conductor for communications and controls may be nearer reality than you'd dream. At least two companies have had a degree of success with the idea. One of them is actually controlling valves, etc. on remote platforms in the Gulf of Mexico from a central platform in the field!

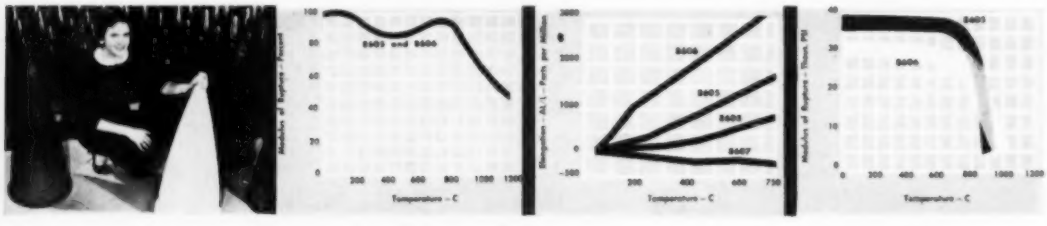
How does it work? It's so simple, you'll wonder why you didn't think of it yourself. By pulsing the cathodic protection current—which is tied into each of the lines running to the central platform—the engineers have been able to send signals and direct the action of valves on the other ends of the lines. Moreover, the company engineers claim the system is reliable enough for any remote installation at sea.

What does this pulsing of the cathodic protection current do to the pipeline coating? Nothing at all. The line is ordinarily under protection and the short pulses that comprise the signals simply over-protect the line for short intervals. The current is never reversed or even allowed to go to zero.

Receivers tied into instruments on the platforms can interpret the pulses, and take appropriate action. The only thing that keeps the new system from being a dream come true is that it's not suitable for voice communication.

Yet another company has had some success in using the steel pipeline for a conductor. This one is reported to have established successful voice communications over a distance of six miles. In this instance, the line is a dry land one, and the pipe is simply used as a conductor for signals in a frequency range that will not affect the coating which plays the part of the insulator. Communication engineers with the company are hopeful of extending the range!

New Super Glass



Oil industry products ranging from pressure vessels to engine parts—all made of glass—are among revolutionary developments you may expect in the near future as a result of the development by Corning Glass Works of an exciting new material named Pyroceram. As described in the August 1957, issue of *The Petroleum Engineer,* the super glass has a predicted cost lower than that of many of the metal alloys and steels now in use and can be shaped by regular glass-making processes — blowing, pressing, or drawing. More important, Pyroceram attains such fluidity in its molten state that it can be formed by centrifugal and investment casting.

Invented by Dr. Donald Stookey of Corning, the

glass is lighter than aluminum, harder than many high carbon steels, has perhaps the world's highest ratio of strength to weight, and in experimental form has registered flexural strengths as high as 60,000 psi.

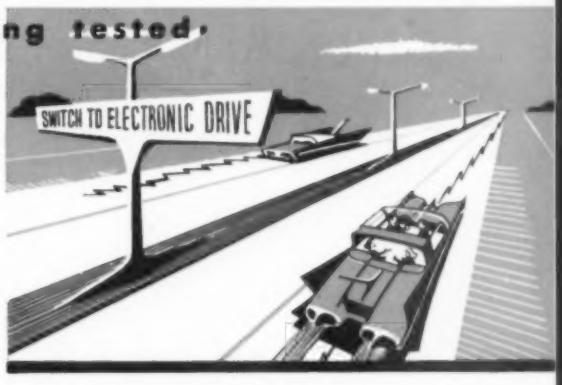
It is non-porus and gas tight and has high resistance to abrasion. It compares favorably with the best electrical ceramics in high frequency dialectric strength, and has variable thermal properties (retaining virtually all its strength up to 1300 F). Early indications are that versions of the glass are nearly as resistant to acid attack as Pyrex glass. Finally, the material may be made, by controlling the heat treatment, either transparent, translucent, or pure white opaque.

How such a wealth of desired qualities in a single material? Actually, says Dr. William H. Armistead, Corning vice president in charge of research and development, Pyroceram makes up a whole family of new materials. To date the company has produced more than 400 different compositions of the glass, with only a fraction of these having been fully tested.

In making Pyroceram, a glass batch containing one or more nucleating agents is melted, then formed and cooled by usual methods. The casting is then heat treated, and during this process billions of submicroscopic crystallites per cubic millimeter are formed by the nucleating agents. Continuing heat causes each of these crystallites to act as the center of crystal growth. Result of the heat treatment: A fine-grained crystalline material.

"It is obvious," states Corning's president, "that Pyroceram — a light, tough, hard, temperature resistant material at relatively low cost — should have a number of important uses." Uses and applications within the oil industry may well prove unlimited.

Highway of the Fufure now being tested.



"Controlled highway — please switch to electronic drive." Such a roadsign need no longer strike you as fantastic, according to RCA's *Electronic Age*, for in demonstrations conducted on a 400-ft stretch of highway near Lincoln, Nebraska, the electronic "highway of the future already has passed its first tests, and immediate benefits to your own present automobile could be realized in roads under construction today.

Under direction of RCA and the State of Nebraska, both unequipped and electronically fitted vehicles have been used in tests begun last October to show the various possibilities of a road whose subsurface electronic circuits beam signals that not only control total movement of specially equipped automobiles but, in case of standard cars without auxiliary equipment, provides, by actuation of flashing highway lights, whole new concepts in traffic safety.

The experimental highway consists of three basic elements operating on three separate frequencies: A sequence of sub-surface detectors capable of reaction to the passage of cars; a radio warning system for following vehicles, controlled by a signal from the detectors, and a guidance system (a cable buried beneath the pavement and running down the center of the traffic lane) to keep each vehicle centered in its lane.

Engineers are making no secret of the exotic plans for the long distance driver to tomorrow: **Overall electronic operation of the automobile during its time on the highway, complete to acceleration, braking, changing of lanes and even break-in announcement of exits and other highway connections through the standard car radio — all this while the driver reads or fights a hangover or ignores his mother-in-law.** Less widely heralded, however, are the benefits that the system could bring to the ordinary car of today. These are actuation of flashing highway lights warning of parked cars or obstacles ahead in the road, automatic warning to a driver following too closely behind another vehicle, and remote operation of warning lights ahead at points of merging traffic. With each car lighting a series of lights several feet to its rear, many multiple-car smashups now occurring all too frequently in fogs and other limited-vision-weather could be averted.

Jet Line Gun Shoots Line Through Conduit

A new "gun" that shoots a nylon line as far as 400 ft through a conduit is now nationally available, according to Graybar Electric Company.

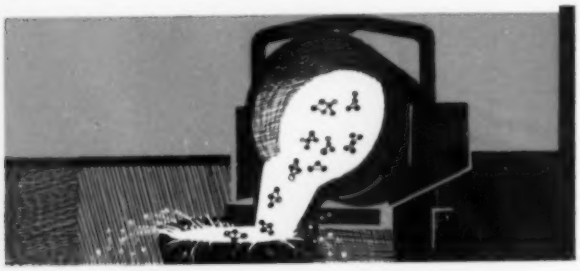
The gun is simple to operate and far quicker than the old fashioned "snaking" methods used to thread *Jet Line Gun Continued*

Jet Line Gun Continued

conduit. It features a packaged spool of nylon line mounted atop the barrel and attached to a sealed cartridge of liquefied gas. Once the cartridge is muzzle-loaded into the gun, a tripper-actuated "firing" pin punctures the cartridge, releasing the jet action of compressed liquefied gas. Travelling through the conduit at high speed, the cartridge lays the line behind it.

Jet Line Gun Company of Charlotte, North Carolina, manufactures the device. It has been tested in vertical as well as horizontal runs and in commercial industrial and telephone installations. The gun is reported useful also in flexible conduits and for fishing in under floor ducts and similar raceways.

Iron Crystals Combine Chemically With Nylon Rubber to Produce New Materials



Minute crystals of iron behaving as chemicals rather than metals impart new properties to copper, nylon, steel, plastics, rubber, and other materials with which they may be combined, according to the *Wall Street Journal*. Known as alpha iron, the crystals are so small that a "billion of them occupy less space than a grain of table salt," and have already been used with copper to produce bearing parts that outlast steel, and with nylon to produce an auto leaf spring insert that withstood the Ford Motor Company's most extreme tests.

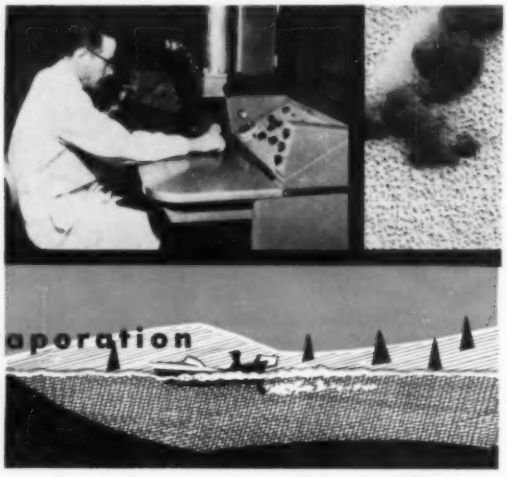
Developed by Dr. Michael Freeman, a Detroit physician engaged in research with the U. S. Navy, the crystals are produced by a complex electrolytic process. For combination with other materials they are placed in a mold with those materials to be mixed and pressed into shape under heat. When combined with non-metallic substances molecular cross linkage results.

Offering, among others, such qualities as superior electrical conductibility in combination with copper, super magnetic properties when mixed with magnetic iron, and nylon base bearings of low dynamic friction, alpha iron, now in limited production, will be used in critical parts where high strength and long-wearing characteristics are desirable.

Microscopic Magnification

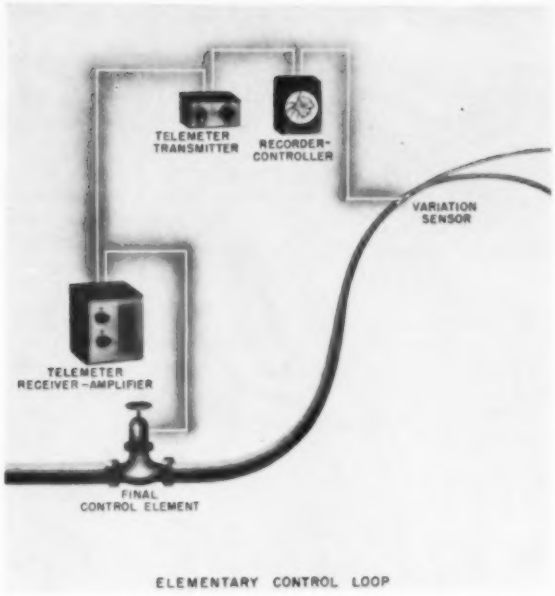
Radio Corporation of America has developed and will put into commercial production this year a new ultramagnifier that quadruples the enlarging power of RCA's electron miscroscope. It increases direct magnification from 50,000 to 200,000 times, and photo-enlargement capability from 300,000 to more than 1,000,000 times.

Chemical Film Reduces Water Evaporation

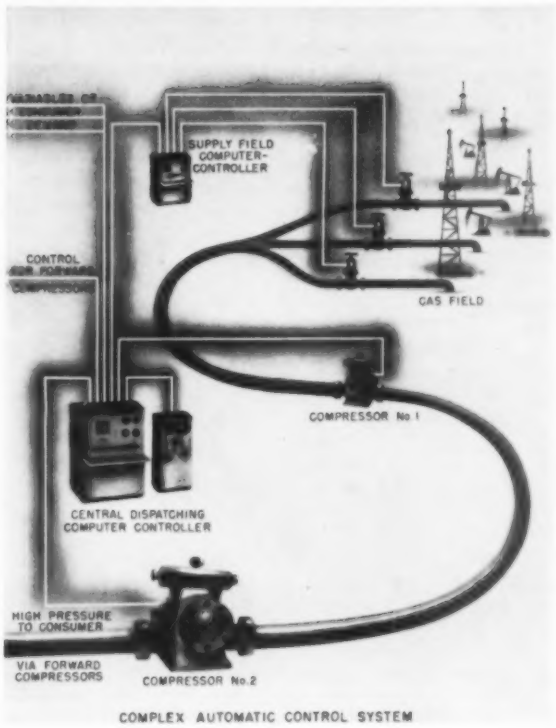


Acknowledging water conservation as the Southwest's number one problem (in some areas evaporation reduces water reservoir supplies 10 vertical ft a year), Southwest Research Institute scientists have had encouraging results from their research into the use of a chemical, used also as a base for cosmetics, which is harmless to humans as well as fish, animal, and plant life.

The chemical, hexadecanol, forms a film one ten millionth of an inch thick over the water surface and serves to dissipate much of the energy of the water molecules that would ordinarily, in the process that is evaporation, attain under heat such rapidity of movement as to be thrown off as water vapor. Experimentation with hexadecanol has brought about water savings of as much as 45 percent and research with the process is continuing.



ELEMENTARY CONTROL LOOP



COMPLEX AUTOMATIC CONTROL SYSTEM

G. A. Barnard, III
Research Engineer, Stanford Research Institute
Menlo Park, California

Automatic Control Systems for Gas Transmission Pipelines

LEADERS in the natural gas industry are taking a long look at the development of automatic control systems for gas transmission and gathering as a means of bolstering profit margins. Control improvements could effect economic gains by increasing the efficiency of dispatching and gathering procedures. Such improvements could be implemented by remote automatic reporting and controlling equipments, interconnected by a data communications system of high reliability.

The industry, recognizing the operational need for technical improvements in dispatching, admits that higher operating efficiencies could be obtained. Opinion varies, however, on the degree of gain in net revenue which would be realized. It has been stated that 85 percent of the monthly cost of operating a pipeline is fixed, being principally long-term amortization of capital investments. Of the 15 percent which is variable, only a small fraction can be controlled by improving operational efficiency. Nevertheless, reducing even this small cost is worth consideration. Although a small part of the total operating costs, it can be an appreciable part of a company's net profit. In addition, the throughput gains realizable for the increased efficiency would undoubtedly be of far greater significance than the savings in direct costs.

Pipeline operators are familiar with the control networks. Most of these systems consist of one central control office which receives requests from various demand points, transmits intake orders to influx points, and transmits power orders to booster stations along the line.

Notice of demand change is received in the central office by the chief dispatcher, who ascertains the current status of gas flow. He decides the best method for modifying flow and performs calculations for determining the degree of flow change needed at compressor stations. Ultimately he transmits control orders to the appropriate input and booster stations.

The dispatcher prefers that major demand changes be requested considerably before needed. This is particularly true with lines which transport gas several hundred miles from source to consumer. Unless sufficient advance warning is given, there is too much lapse of time between the occurrence of a flow-rate change at the delivery point and at the supply point.

Advance knowledge allows the dispatcher to ready all compressor stations along the line. With coordinated programming of control orders, demand changes can be accommodated rapidly and smoothly. But, although predictions of long-term user demand are possible on a broad basis, daily or hourly fluctuations of amount and dis-

(Continued on Page D-70)

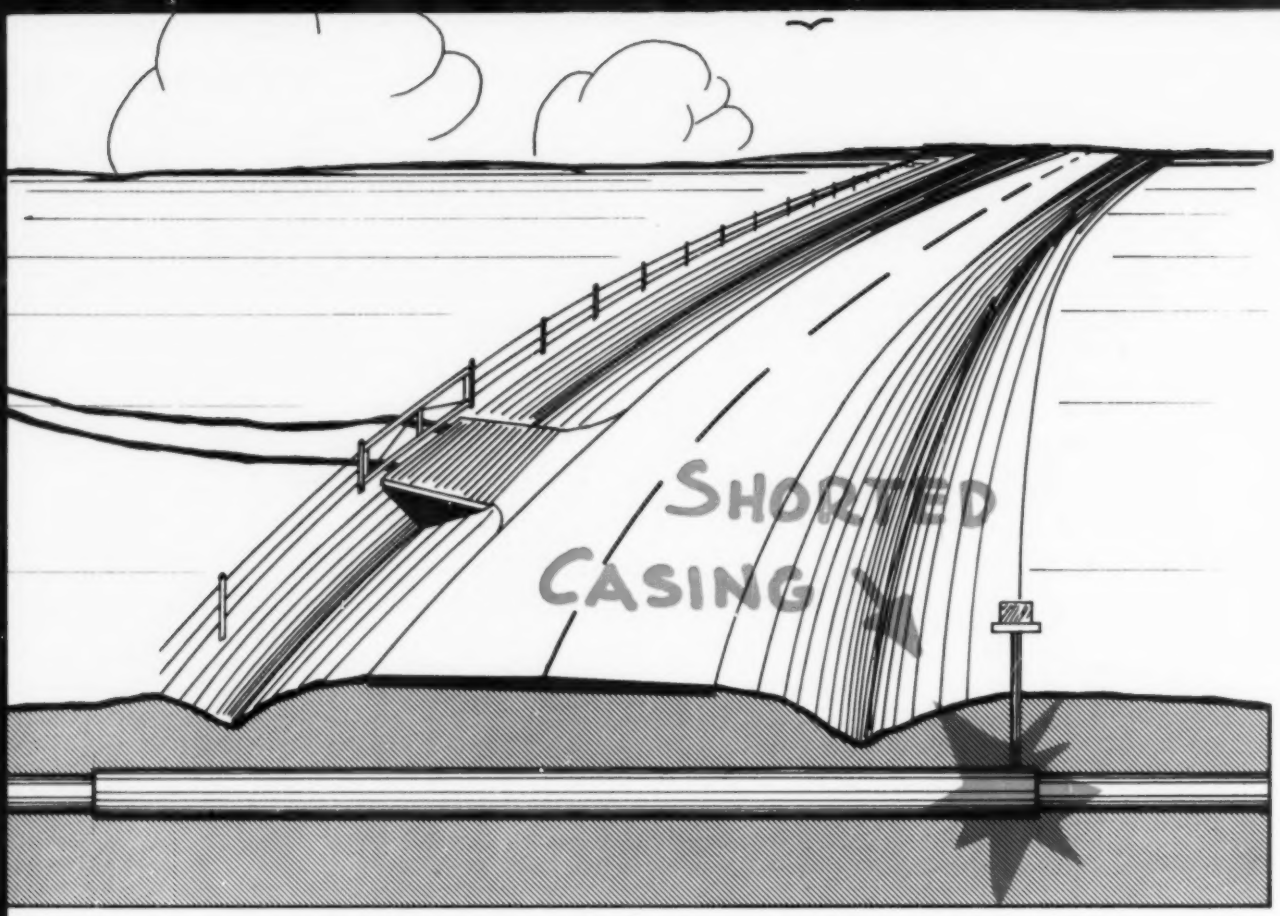


FIG. 1. Shrted casings are vexing problem of gas companies — expensive to repair — yet not too difficult to live with. What has been needed is inexpensive means of repair.

P 615.63.

A New Way to Repair Shorted Casings

Dig a small bell hole, cut the top of the casing and mitre it to center on the carrier pipe, then install new bushings, etc.

Tod Pazdral and Jack Duke
Tod Pazdral Pipeline Specialties, Houston, Texas

Tod Pazdral

Tod Pazdral *has been in the pipeline business all of his professional life. He was superintendent of construction for Transcontinental Gas Pipe Line Corporation, superintendent of pipelines for Tennessee Gas and held various positions with Lone Star Gas Company. After years of being called on by salesmen, he decided to "join 'em" and started Tod Pazdral Pipeline Specialties Company better known as ToPaz. Pazdral is a graduate of Trinity University.*

A DIFFICULT PROBLEM confronting many pipeline companies in general — and corrosion engineers in particular — is what to do about the shorted casings at highway and railroad crossings.

The problem can be vexing because it is often difficult to justify repairs. The cost of "living" with a shorted casing may be slight — the cost of repairs great. The expense of the additional protection current demand caused by the short seldom exceeds a few hundred dollars per year whereas the cost of repairing the short may run several thousand dollars.

Another factor that complicates the problem is safety practice involved in making the repairs. For the most part, present day repairs are effected in this manner: First, about 200 ft of the carrier pipe is exposed along with a few feet of the shorted casing end. Because the line in pressured, a good portion of this ditching must be done by hand. Second, the carrier pipe is juggled until the end seal comes loose and can be removed. Next, the seal and bushing are replaced and the pipe is backfilled at a grade of sufficient elevation to keep it centered in the casing and under no strain.

Many pipeline companies do not consider this present day method of

repair to be good safety practice, preferring to bide their time until the line is out of service.

Yet, repairs are desirable. Slight as the current requirements of the short are, they will add up to a considerable figure over the years; and the very knowledge of a shorted casing always casts a shadow of doubt on the degree of protection actually being afforded the carrier pipe.

New Method

A solution to this method has been devised by engineers with Tod Pazdral Pipeline Specialties of Houston, Texas. It is a new method of making repairs that reduces the cost and eliminates any handling or juggling of the carrier pipe.

In a nutshell, it's this simple: Expose a few feet of the end of the shorted casing and about the same amount of carrier pipe. Then cut the top of the casing so it can be centered on the carrier pipe. Remove the end seals, install new ones, and add a new casing bushing. Then cover the gap in the top of the casing with a piece of scrap pipe. Backfill.

This method is not offered as an inexpensive procedure for correcting casing shorts, but the advantage obviously will result in a marked reduction in the expenses of repairs and afford a greater degree of safety, thus making the project more feasible.

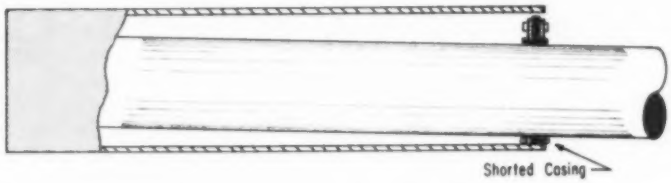


FIG. 2. Most casing shorts are caused by the carrier pipe crushing the supporting insulators and touching the casing near the end.

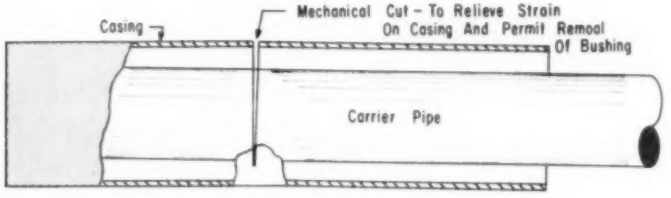


FIG. 3. First step in new repair method is to cut the casing — almost all the way around — and let it fall to concentric position. Then remove bushing.

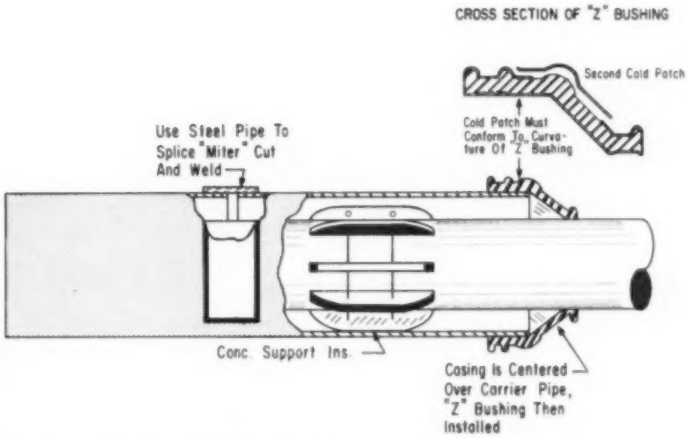

CROSS SECTION OF "Z" BUSHING
Second Cold Patch
Cold Patch Must Conform To Curvature Of "Z" Bushing
Use Steel Pipe To Splice "Miter" Cut And Weld
Conc. Support Ins.
Casing Is Centered Over Carrier Pipe, "Z" Bushing Then Installed

FIG. 4. How repairs are effected. Install new insulator and "Z" bushing — which is cut in half cemented and wrapped — then weld casing patch over the cut in the casing.

How It Works

Most casing shorts are either direct or indirect results of poor end seal installations. Directly, insufficient support of the carrier pipe load permits the carrier to settle into direct metal-to-metal contact with the end seal and/or casing pipe. Indirectly, distortion of the end seal by carrier pipe load permits entry of moisture into the casing, setting up the ground between carrier and casing. See Fig 1.

Removal of the end seal presents a difficult problem unless the carrier can be recentered or the casing cut to relieve the strain on the end seal. Any relocation of the carrier pipe requires stripping-out a long section of line to gain necessary slack. Use of hand torches for cutting work on lines in high-pressure service is also objectionable.

As shown in the accompanying drawings, ToPaz engineers recommend a mechanical cut be made in the casing a short distance from the end. This cut can be made in a relatively small bellhole, thus eliminating stripping-out many feet of line. The cut, being made mechanically, eliminates hand torch operations on or near the line and permits precise control over the operation.

Location of the cut is selected to give the best centering of the carrier in the casing. The farther from the end of the casing that the cut is made, the smaller the resultant gap in the casing. The cut should not be a full 360 degrees around the casing but a small section on the bottom should be left for support and to facilitate handling.

A pipe saw with an air motor drive is recommended for this cutting operation. This saw requires a 16½-in. clearance around the pipe and travels approximately 2½-in. per minute, which makes for fast, efficient cutting in limited working space.

The last drawing shows the casing centered around the carrier pipe and a spliced mitre cut completed to recover the strength of the casing and make it watertight. A new insulator inside the casing and new end seal has been installed to correct the casing short.

Concentric support insulators and spliced "Z" bushings are recommended for establishing and maintaining good insulation between the carrier and casing pipe.

A word should be added regarding the installation of the "Z" bushing. This heavy rubber seal should be cut lengthwise, slipped over the carrier pipe and casing — then vulcanized, wrapped, and clamped. The efficiency of the completed job should be close to that of new construction. ★ ★ ★

P 613.365

PIPE LINE COMMUNICATION & CONTROL

Pipeline microwave reaches 21,000 miles

Dean Hale, *Technical Editor*

GROWING IMPORTANCE OF MICROWAVE radio systems in providing the nation's pipeline network with reliable communications is indicated by figures revealed in THE PIPELINE ENGINEER'S Fourth Annual Microwave Survey.

Impressive is the word for the latest figures — that show a total of 21,661 miles and 901 stations in service or being installed, all operated by U. S. pipeline companies.

During the past 12 months (May 1, 1957, to April 30, 1958), pipeline companies added 2112 miles and 102 stations — a figure even better than 1957's 1700 miles and 80 stations.

Systems under construction and extensions to systems add even further evidence that microwave usage is growing — current figures show that 3697 circuit miles and 135 stations are "under construction" and will be placed in operation during the next 12-month period.

Also revealed in the current survey — but not listed because they are still in the talking or early planning stages — are some 1500 miles of microwave circuits and 65 stations.

Under Construction

Nearing completion is Texas Gas Transmission's long distance system involving 800 circuit miles and 32 stations between Owensboro, Kentucky, and Lake Charles, Louisana. (This system was discussed in the April, 1957 issue of THE PIPELINE ENGINEER.)

Atlantic Pipe Line Company is currently building a 270-mile, 10-station system between Bethel, Pennsylvania, and Rochester, New York, to operate on the 2000-mc band; system will have 8 channels.

Between Los Angeles and Farmington, New Mexico, Four Corners Pipe Line Company is installing an 835-mile, 15-station system that will span elevations from nearly sea level to almost two miles high. This 11-channel system also will operate in the 2000-mc band.

For the new Laurel Pipe Line between Philadelphia and Pittsburgh, Pennslyvania, channel expansion on the Atlantic-Sinclair system will involve 420 miles and 25 stations, all in the 2000-mc band with 45 channels.

Shell Oil Company is currently installing a 211-mile, 4-station system between Los Angeles and Bakersfield, California, with 16 channels operating in the 6700-mc band.

Sinclair Pipe Line Company is extending its system in Ohio, with a 125-mile, 5-station system under construction between Clinton and Marion; system will have 23 channels and operate in the 2000-mc band.

Three systems designed to operate "offshore" in Louisiana are also under construction — including a 216-mile, 11-station system with 11 channels between Harvey and Grand Isle for the CATC Group, to be operated by Continental Oil Company. (See Page D-50-D, this issue); a 220-mile, 11-station system with 40 channels between Venice and Leesville for Radio Dispatch Company; and a 1-mile, 2-station single channel system for Pure Oil Company, all in the 6700-mc band.

Service Pipe Line Company continues to extend its microwave communications. Latest addition— now under construction — is a 295-mile, 10-station system between LaPlata, Missouri, and Manhattan, Illinois, that will have 15 channels in the 6700-mc band.

El Paso Natural Gas Company is also expanding its communications network, with 250-miles and 7 stations under construction between Midland, Texas, and El Paso, Texas. System will have 12 channels and operate in the 6700-mc band.

Texas Pipeline Company is building a 54-mile, 3-station system with 2 channels between Wichita Falls and Tolbert, Texas, using 6700-mc band.

An up-to-date tabulation of U. S. pipeline microwave installations is presented in the following table.

Pipeline Microwave Systems: May, 1958

Here's where more than 21,000 miles and 900 stations are located, according to *The Pipeline Engineer's* survey

Name of Company Owning and/or Operating System	Date In Service	From	To	Length Miles	No. of Stations	Freq. Band	No. of Channels
Atlantic Pipe Line Co.	1957	Dallas, Tex.	Temple and Esart, Tex.	162	6	2000	15
Atlantic Pipe Line Co.	U. C.	Bethel, Pa.	Rochester, N. Y.	270	10	2000	8
Atlantic Seaboard Corporation	1957	Standardsville, Va.	Dranesville, Va.	97	4	2000	6
Atlantic-Sinclair System	1949	Philadelphia, Pa.	Reading, Pa.	70	5	2000	6
Atlantic-Sinclair System	1954	Philadelphia, Pa.	Pittsburgh, Pa.	460	23	2000	9
Buffalo Pipe Line Corporation	1954	Caledonia, N. Y.	Marrowlock Hill, N. Y.	19	2	960	1
Clinchfield Coal Corporation	1956	Osborne Gap, Va.	Dante, Va.	18	2	6700	3
Colorado Interstate Gas Co.	1954	Colorado Springs, Colo.	Keyes, Okla.	281	7	2000	3
Colorado Interstate Gas Co.	1957	Colorado Springs, Colo. Keyes, Okla.	Lakin, Kans. Sanford, Tex.	299	12	2000	28
Continental Oil Co. (CATC)	U. C.	Harvey, La.	Grand Isle, La.	216	11	6700	12

Name of Company Owning and/or Operating System	Date In Service	From	To	Length Miles	No. of Stations	Freq. Band	No. of Channels
Dow Chemical	1957	Thompsons, Tex.	LaWard, Tex.	79	4	6700	3
El Paso Natural Gas Company (San Juan System)	1952	Farmington, N. M.	Topock, Ariz.	450	11	6700	4
El Paso Natural Gas Company (Permian System)	1953	Midway, Tex.	Jal, N. M.	287	13	2000	21
El Paso Natural Gas Company (Western System)	1954	El Paso, Tex.	Farmington, N. M.	478	12	2000	4
El Paso Natural Gas Co.	U. C.	El Paso, Tex.	Midland, Tex.	250	7	6700	12
Four Corners Pipe Line Co.	U. C.	Farmington, N. M.	Los Angeles, Calif.	835	15	2000	11
General Petroleum Corp.	1955	Santa Fe Springs, Calif.	Brea, Calif.	15	2	960	1
Georgia Gas Company	1957	Gainesville, Ga.	Compressor Station	15.5	2	2000	1
Humble Pipe Line Company	1953	Houston, Tex.	Kempner, Tex.	450	19	6700	3
Industrial Gas Supply Corp.	1955	Houston, Tex.	Alcomag, Tex.	20	2	6700	10
Interstate Petroleum Communications, Inc. (Shell P. L.)	1951	Cushing, Okla.	Elk City, Okla.	160	8	6700	3
Interstate Petroleum Communications, Inc.	1955	Wood River, Ill.	Maryland Hts., Ill.	22	2	6700	8
Interstate Petroleum Communications, Inc.	1953	Springfield, Mo.	Lawrence, Mo.	30	2	6700	4
Kansas-Nebraska Natural Gas Co.	1957	Palco, Kans.	Phillipsburg, Kans.	42	3	6700	4
Kansas-Nebraska Gas Co.	1957	Lakin, Kans.	Tyrone, Okla.	72	3	6700	4
Laurel Pipe Line Co. (expansion of Atlantic-Sinclair Pipe Line)	U. C.	Philadelphia, Pa.	Pittsburgh, Pa.	420	25	2000	45
Magnolia Petroleum Corp.	1957	Morgan City, La.	Block 126 (Offshore)	74	5	2000	3
Michigan Wisconsin Pipe Line Co.	1954	Hansford, Tex.	Detroit, Mich.	1540	59	2000	6
Mid Valley Pipe Line Company	1950	Longview, Tex.	Lima, Ohio	1000	42	6700	10
Natural Gas Pipe Line Company of America	1953	Downers Grove, Ill.	Aurora, Ill.	20	2	6700	13
Natural Gas Storage Company of Illinois	1953	Herscher, Ill.	Cabery, Ill.	15	2	6700	2
New York State Natural Gas Corp.	1955	Syracuse, N. Y.	Utica, N. Y.	60	3	6700	2
Ohio Oil Company	1957	Findlay, Ohio	Bridgeport, Ill.	322	17	6700	24
Ohio Oil Company	1957	E. St. Louis, Ill.	Martinsville, Ill.	150	7	6700	5
Oklahoma Mississippi River Products Pipe Line (Sunray)	1952	Purcell, Okla.	Ada, Okla.	82	5	960	1
Oklahoma Natural Gas Company	1954	Muskogee, Okla.	Chickasha, Okla.	220	11	2000	15
Panhandle Eastern Pipe Line Co.	1952	Kansas City, Mo.	Tuscola, Ill.	400	18	6700	9
Plantation Pipe Line Company	1953	Bremen, Ga.	Athens, Tenn.	156	7	2000	13
Platte Pipe Line Company	1954	Casper, Wyo.	Wood River, Ill.	1007	44	6700	9
Pure Oil Co.	U. C.	Offshore, La.	———	1	2	6700	1
Radio Dispatch Co.	U. C.	Venice, La.	Leesville, La.	220	11	6700	40
Richfield Oil Corporation	1953	Los Angeles, Calif.	Sulphur Mtn., Calif.	60	3	6700	2
Richfield Oil Corporation	1956	Saddle Peak, Calif.	Gorman, Calif.	220	12	2000	37
Salt Lake Pipe Line Company	1952	Salt Lake City, Utah	———	35	2	960	4
Service Pipe Line Company	1956	Bretch, Okla.	El Reno, Okla.	90	4	6700	5
Service Pipe Line Company	1951	Snyder, Tex.	Eldorado, Tex.	143	9	6700	7
Service Pipe Line Company	1957	Freeman, Mo.	LaPlata, Mo.	160	7	6700	10
Service Pipe Line Co.	U. C.	LaPlata, Mo.	Manhattan, Ill.	295	10	6700	15
Shell Oil Company	1957	Brea, Calif.	Long Beach, Calif.	18	2	6700	8
Shell Oil Co.	U. C.	Los Angeles, Calif.	Bakersfield, Calif.	211	4	6700	16
Shell Pipe Line Company	1957	Cushing, Okla.	Chelsea, Okla.	120	6	6700	22
Shell Pipe Line Company	1958	Roswell, N. M.	Hobbs, N. M.	93	5	6700	6
Shell Pipe Line Co.	1958	Midland, Tex.	McCamey, Tex.	130	6	6700	22
Sinclair-Continental System	1956	Ponca City, Okla.	Houston, Tex.	760	29	6700	85
Sinclair Pure System	1953	Cushing, Okla.	Independence, Kans.	190	9	6700	24
Sinclair Pure System	1953	Independence, Kans.	Salisbury, Mo.	260	13	6700	23
Sinclair Pure System	1953	East Pittsburgh, Pa.	McDonald, Pa.	20	2	6700	5
Sinclair Pure System	1954	Salisbury, Mo.	East Chicago, Ind.	475	21	2000	24
Sinclair Pipe Line Company	1957	Quincy, Ill.	Mazon, Ill.	(8 Terminals)		6700	—
Sinclair Pipe Line Company	1956	Clinton, Ohio	East Pittsburgh, Pa.	90	5	2000	5
Sinclair Pipe Line Company	U. C.	Clinton, Ohio	Marion, Ohio	125	5	2000	23
Sinclair Pipe Line Company	1958	Marion, Ohio	Toledo, Ohio	90	5	2000	4
Southern Natural Gas Co.	1958	Toca, La.	Olga, La.	45	3	2000	2
Standard Oil Company of Indiana (Products Pipe Line Dept.)	1954	Morehead, Minn.	Mandan, N. D.	200	8	2000	4
Sun Pipe Line Company	1953	Hoffman, Tex.	Humble, Tex.	15	2	960	1
Sun Pipe Line Company	1955	Sour Lake, Tex.	Saratoga, Tex.	13	2	960	1
Sun Pipe Line Company	1955	Barbers Hill, Tex.	Liberty, Tex.	18	2	960	2
Tennessee Gas Transmission Co.	1955	Kinder, La.	Oakdale, La.	23	2	6700	2
Tennessee Gas Transmission Co.	1957	Oakdale, La.	Latanier, La.	40	3	6700	3
The Texas Company	1953	Salem, Ill.	Kaskaskia, Ill.	20	2	960	2
Texas Eastern Transmission Corp.	1954	Shreveport, La.	Linden, N. J.	1400	57	2000	8
Texas Gas Transmission Corp.	1950	Guthrie, La.	Sharon, La.	45	3	6700	5
Texas Gas Transmission Corp.	U. C.	Owensboro, Ky.	Lake Charles, La.	800	32	2000	60
Texas Illinois Natural Gas Pipe Line Company	1952	Houston, Tex.	Chicago, Ill.	1004	40	6700	9
Texas Pipe Line Co.	U. C.	Los Angeles, Calif.	Bakersfield, Calif.	211	4	6700	16
Transcontinental Gas Pipe Line Corporation	1952	Falfurrias, Tex.	Linden, N. J.	1752	61	2000	11
Trunkline Gas Company	1954	Houston, Tex.	Tuscola, Ill.	1000	32	2000	8
United Gas	1953	Jackson, Miss.	Montpelier, La.	126	6	2000	8
Union Oil Company	1955	Torrey Hill, Calif.	Mulholland, Calif.	35	3	2000	4
Union Oil Company	1957	Los Angeles, Calif.	San Francisco, Calif.	637	21	2600	48
Wilcox Trend Gathering System, Inc.	1954	Cuero, Tex.	Mineral, Tex.	62	4	6700	5
Wilcox Trend Gathering System, Inc.	1956	Mineral, Tex.	George West, Tex.	20	1	6700	3

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C-R-C Kelley Coal Ripper shown making a pass through a strip mine. Penetration depth is a maximum 7 feet.

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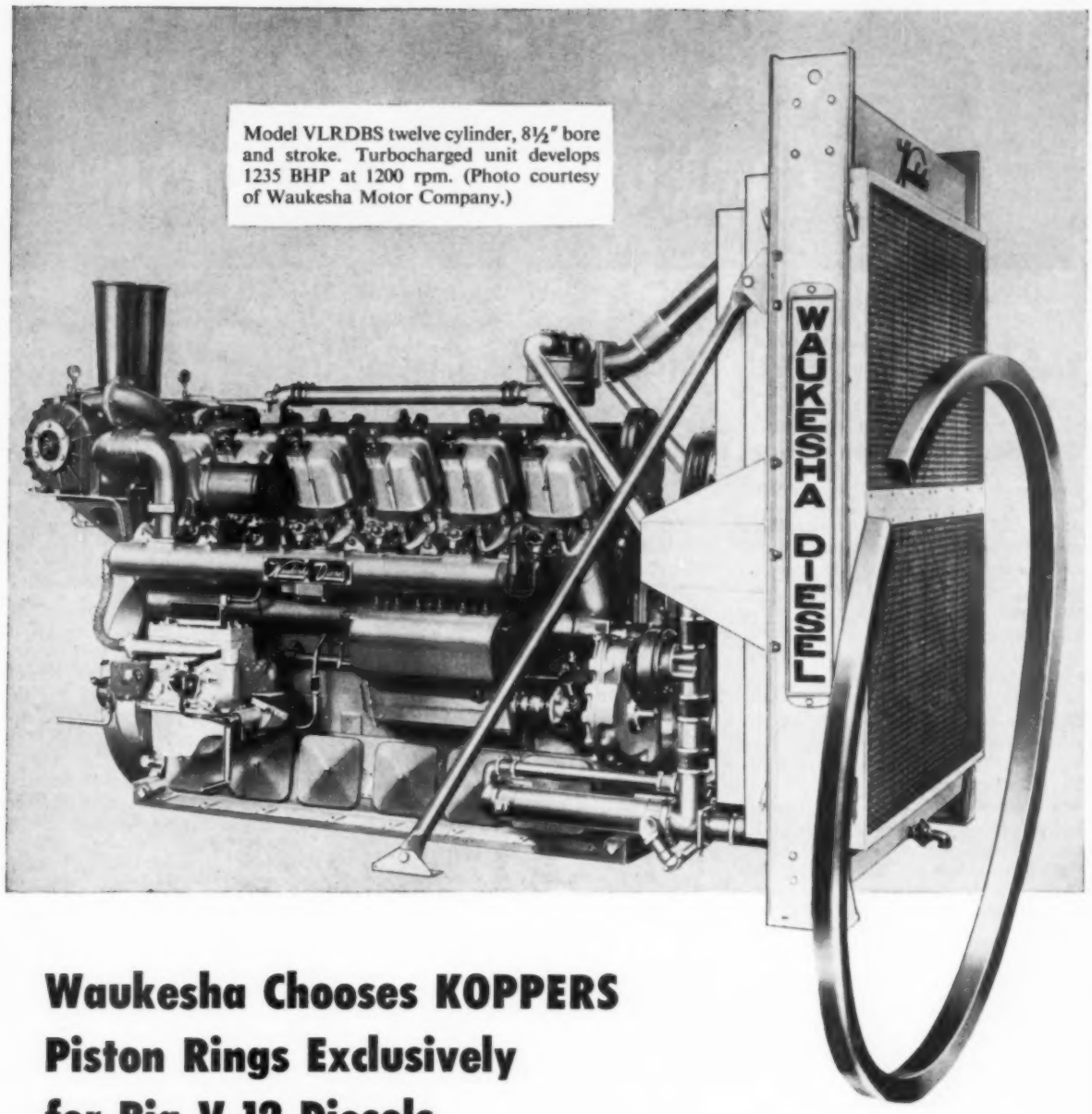

Model VLRDBS twelve cylinder, 8½" bore and stroke. Turbocharged unit develops 1235 BHP at 1200 rpm. (Photo courtesy of Waukesha Motor Company.)

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PIPE LINE COMMUNICATION & CONTROL

CATC will have Microwave Circle in the Gulf

Circular pattern of stations eliminates much standby equipment

AUTOMATIC CONTROL and telemetering of off-shore operations to include opening and closing of valves, starting and stopping of motors, and the remote reading of tank gages, pressures, and flow volumes, will be made possible in a new 175-mile microwave system under construction in the Gulf of Mexico for CATC (Continental Oil, Atlantic Refining, Tidewater Associated, and Cities Service). Specifications for the system were provided by CATC after a detailed study of off-shore communications needs.

Initially, microwave will provide each of the CATC stations with a private line to Harvey (terminus for the system) and a "party line" and maintenance channel for all stations in the system.

Eventually, says Motorola, Inc., builder of the system, simple "add-on" equipment to provide automatic control and telemetering will make it possible for many of the platforms to be entirely unmanned, except for visits by maintenance personnel.

Devised to bring maximum versatility and reliability for platforms located off the Louisiana Coast, as well as four on-shore stations, the network, consisting of nine stations connected in a "loop", will not only bring vast improvements in off-shore communications methods but will make the two-way radio equipment presently in use even more effective by extending the range and improving its reliability.

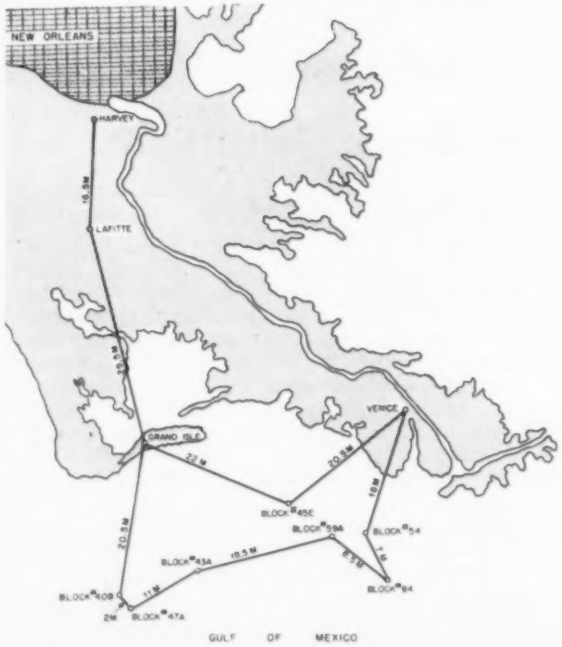
The new CATC microwave system incorporates maximum provisions for uninterrupted service. Should there be failure of any transmitter or receiver, or of a complete RF rack, or of propagation between any two loop stations, the network would automatically adjust itself to an alternate system within two seconds of such a failure.

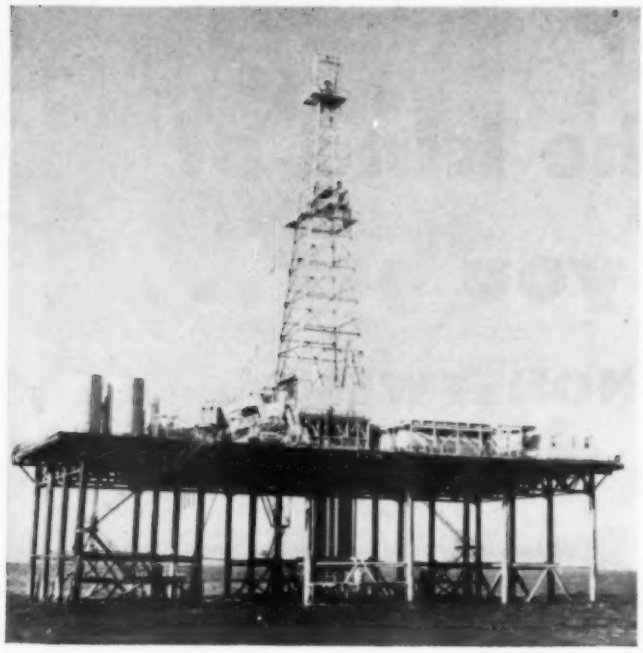
How? The course of the signal path would automatically change into a "Y" at the Grand Isle station (see diagram), where operation of the loop is continuously monitored by tones transmitted around the loop and received back at Grand Isle. Interruption of such tones causes the switch to the "Y" operation, under which system Grand Isle would transmit signals to both sides of the loop.

When such a switchover operation is initiated, it occurs in less than 100 milliseconds of propagation interruption and two seconds after one of the sending circuits indicating an equipment fault is closed. Upon correction of the fault, the system automatically reverts to "loop" operation.

Harvey, Lafitte, and the portion of Grand Isle not in the loop have full stand-by equipment with instantaneous bi-lateral switching. With bi-lateral switching, operation is automatically transferred from one rack of equipment to the other, interchangeably. A switchover panel contains the switching, timing, and control circuits associated with the automatic switchover function. The circuit closure required

Diagram shows how the nine stations in the microwave system are connected in a "loop," providing maximum reliability.





The Block 47A platform used by CATC as a combination drilling and producing station. This facility is the origin of the 12-in. CATC pipeline which extends to Grand Isle.

to initiate this function is provided by the transmitter and receiver failure-sensing circuitry.

In the 6000 to 7000 mc band in which it operates, the microwave equipment in the CATC installation provides a linear broad-band system for reliable point-to-point transmission. The pass band from 300 cps to 3 megacycles permits simultaneous transmission of more than 120 single sideband voice channels. Operation at these frequencies permits the use of high gain, highly directional antennas, and tower mounted reflectors. With this high antenna gain, it is possible to operate the transmitter at a conservative power output.

The use of long-life (20,000 useful hours of life at constant output is not uncommon) reflex klystrons permits generation and direct frequency modulation of the microwave RF carrier in one tube.

This equipment provides freedom from external noise and other sources of interference, which affect equipment operating at lower frequencies. At shore stations, tower-mounted reflectors enable all electrical elements to be kept at ground level of simplified servicing, and the use of curved reflectors provides an additional 3 to 8 db gain contrasted to losses normally encountered in a transmission line.

Off-shore platforms are approximately 55 ft above normal sea level. Together with a 20-ft long, 4-in. diameter pipe, which will be bolted to these platforms to serve as vertical antenna mounts, each of the six off-shore stations will then have approximately 75 ft of antenna height.

At these stations, paraboloid antennas, two on each pipe, will be connected to RF equipment via flexible wave guides. The "dish" antennas, 4 and 6 ft in diameter, depending on requirements, are mounted directly on the pipes. These antennas provide high radiated energy concentration with beam widths of 1.7 degrees for the 6-ft units and 3 degrees for the smaller paraboloids.

Microwave facilities at Grand Isle include complete Motorola equipment for operation in three directions. Three passive reflectors, each fed by its own paraboloid on the ground, are mounted atop a 240-ft tower.

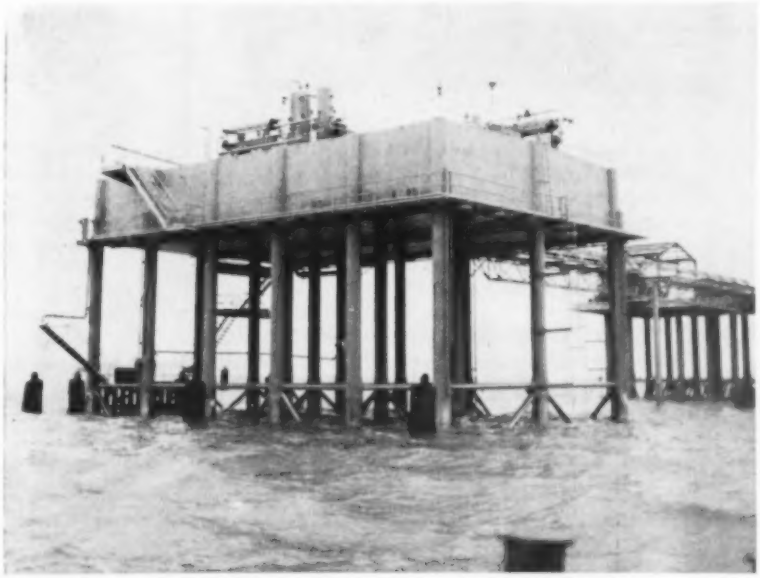
Harvey, terminal for the network, requires only the one antenna combination, with the reflector at the top of a tower 120 ft high. Passive reflectors at Lafitte are atop a 160-ft tower, and a similar installation at Venice utilizes a 200-ft tower.

At these stations, the paraboloids are mounted on roofs of the microwave buildings and direct their energy vertically to the reflector. The reflector, in turn, directs the concentrated energy horizontally to the next microwave station. Sturdy towers and anodized aluminum antennas and reflectors used in the system are designed to withstand wind velocities exceeding 150 mph.

Special precautions also were taken for facilities housing the microwave equipment. To counteract highly corrosive conditions, double walled, anodized aluminum housings were selected for the off-shore stations. These buildings are 4 ft wide by 6 ft long by 8 ft high. On-shore stations are of conventional concrete. Dehumidifying facilities are being provided at all stations to counteract heat and high humidity.

* * *

Tank Battery at Block 84. Oil from this platform is moved by barge to on-shore receiving stations.



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Bill Lewis, typical service engineer, proves how you can depend on Honeywell for fast, on-the-spot service even in emergencies.

3 It took Bill two hours to drive to the plant through the storm. He spotted the trouble immediately; a thermocouple and its protecting tube had burned out. It might have meant four to five thousand dollars' worth of damage.

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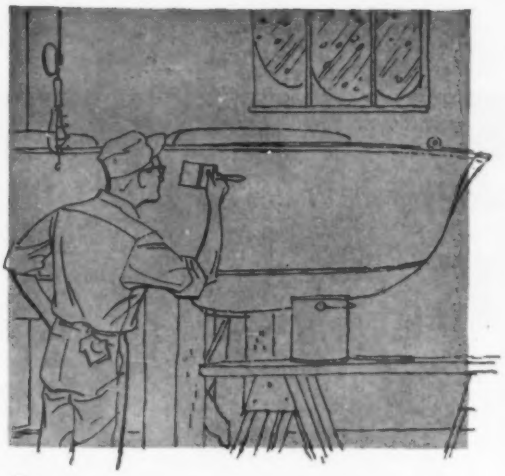
- Application engineering for installation and startup.
- Service engineering help from your nearby Honeywell branch.
- Periodic service and swift help in emergencies.
- Training of your operators at the Honeywell Instrumentation Education Center.



1 Bill Lewis, service engineer at Honeywell's Fort Wayne branch, was in his garage, touching up the paint on his 13-foot outboard. The bowling match had been called off that night because of the snowstorm, and Bill was glad to be home.

2 At 9:30 a call came from the Crosby Laughlin Division of American Hoist and Derrick Company in Fort Wayne. A controller on a galvanizing kettle wasn't working and unless it was fixed fast, the pot would either freeze or burn out. Bill said he would be out right away.

4 Bill didn't have a thermocouple with him that would fit, so he improvised a temporary couple and protecting tube and got the system going. Early the next morning he called the Honeywell branch in Indianapolis and had the correct thermocouple and tube shipped quickly to the plant. Next day, he carefully checked out the entire installation.

5 Now, Crosby Laughlin Division is signed up with the Honeywell Periodic Service Plan, and its complete instrumentation is checked and serviced every month. Any spare parts needed are now available at Honeywell's Fort Wayne branch. Bill hasn't had to make another emergency call to the plant since.

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PIPELINE WELDING

Part 2 — Making the weld

Richard D. Morel
Senior Engineer,
Transcontinental Gas Pipe Line Corp., Houston, Texas

IN the preceding installment* we discussed manual shielded metallic arc welding in general terms. Now we will specifically discuss field welding as applied to pipelines.

There are two principal methods of welding pipe on cross-country lines where the pipe is more or less in a horizontal plane. The nomenclature of the methods depends on the direction of welding in the vertical plane established by the pipe ends. The two methods are — vertical up, or uphill and vertical down or downhill.

FIG. 1

The Uphill Method

This weld is made with the arc progressing from bottom toward the top. The line up is wider spaced with a gap of about ⅛-in. (as compared with a gap of about 1/16-in. for downhill welds). The method requires lower welding currents and slower speeds than other methods.

An advantage of uphill welding is that the slower speeds and heavier beads that are common to the method, provide a better opportunity for slag and gas—that otherwise might be entrapped in the metal—to be melted out. Also, the heavier beads reduce the total number of passes required per weld on **heavy wall pipe** resulting in less cleaning time and an overall speed-up in welding. At the same time, uphill welding requires slightly more welding rod than the downhill method because of the increase in spacing.

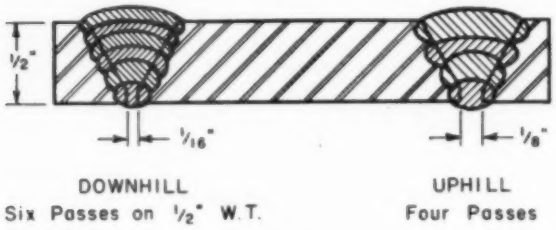


FIG. 2

Comparison of uphill and downhill welding. Actually, a satisfactory pipe weld, meeting all existing code requirements can be produced using either the uphill or the downhill method. The latter utilizing higher welding currents and faster welding speeds has advantages if the pipe is less than ½-in. wall thickness.

*The Pipeline Engineer, April 1958, page D-85.

The Downhill Method

Because most pipelines are ½-in. wall or less the downhill direction of welding (top to bottom), is used more than uphill. This method of welding will be discussed step by step, proceeding from the stringer bead and related problems, to the final pass.

The stringer bead or first pass. The stringer or first pass is perhaps the most important bead of the pipe weld. As a practical field expedient, stringer beads must hold several joints of pipe together while they are subjected to bending stresses resulting from normal handling of the pipe during the construction process.

A downhill stringer bead is applied using a drag technique. The electrode coating rests on the bevel as the electrode is dragged around the circumference.

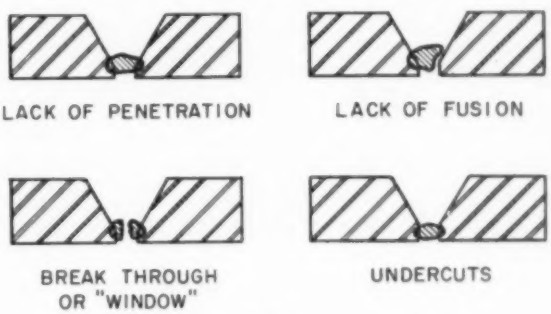


FIG. 3

Stringer bead defects. Considering the function of the stringer bead, the importance of its quality can readily be seen. Before describing the methods and problems involved in producing a sound stringer bead, it would be useful to define the type defects that might occur. The four most common ones are shown above.

Lack of penetration is the failure of the stringer bead to penetrate to the root of the weld.

Lack of fusion is failure of the weld metal to fuse or bond to the base metal.

Burn through is simply a void in the stringer bead where the weld puddle has been blown into the pipe. This defect is usually referred to as "a window" in the stringer bead. Proper application of the hot pass can fill in these windows so that they do not remain as a defect in the completed weld. However, attempts to fill in windows will at times

cause them to enlarge, resulting in globular deposits of weld metal building up on the inside of the stringer bead. These are called "grapes."

Undercut of the stringer bead is the burning away of the side walls of the welding groove at the edge of the weld metal. On the stringer bead this undercutting may occur internally and externally. **The internal undercut** can only be corrected if the weld is accessible from the inside. This is not always possible. **The external stringer bead undercut** is usually eliminated by the proper application of the hot pass. When it is *not* burned out by the hot pass, the defects that remain are referred to as "slag lines" or "wagon tracks."

PIPE END PREPARATION

The usual dimensional requirements for a pipe bevel are as shown here.

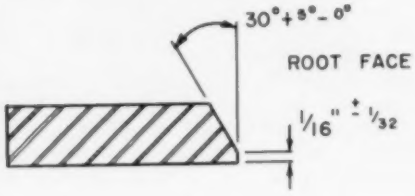


FIG. 4

There are two principal ways of making bevels. At the pipe mill they are usually machined, in the field usually torch cut. On torch cut bevels the root face is applied to the bevel by filling or grinding with a disc grinder.

A fundamental requirement of a good welding procedure is that the surface of bevels be free of all foreign materials such as rust, grease, scale, etc., and also free of fins, tears, etc., that might adversely affect welding.

Foreign material may cause poor fusion and porosity which is undesirable in the weld; fins and tears on the bevel surface interfere with electrode manipulation.

A recommended line up for downhill welding is as shown below.

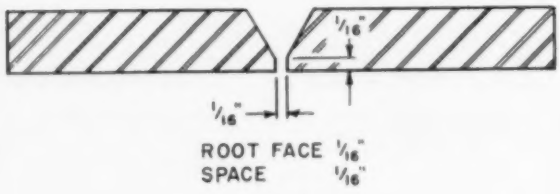


FIG. 5

Dimensional Variations

All manufacturing processes require a certain amount of dimensional tolerance, and pipe manufacturing is no exception. Dimensional variation may lie within accepted manufacturing specifications and still present difficult line-up problems in the field, even when the pipe-ends are rounded perfectly by the line-up clamps. Failure of the latter to round out pipe ends can contribute to greater variation than shown in the following examples.

If the line-up is uniform, that is, the root face and space are exactly 1/16 in. and dimensionally uniform around the circumference with no offset or hi-low present, the welder would have little difficulty in producing a stringer bead completely free of defects.

For example, some of the pertinent pipe manufacturing tolerances of 30-in. API 5LX pipe are as follows:

Bevel 30° + 5° — 0°
Root Face 1/16-in. ± 1/32-in.
Outside Diameter Minus 1/32-in. plus 3/32-in. as measured with a diameter tape. (This tolerance only applies to each end of the pipe for a distance of 4-in. The tolerance for the remainder of the length of 1% of the diameter)
Wall Thickness Minus 10% plus 15%
Bevel Angle: A variation in the bevel angle would not introduce any welding problem in the line-up.

Effect of These Manufacturing Variations on the Line-Up

Root face: A variation in the root face dimension of from 1/32-in. to 3/32-in. introduces many problems. This variation could appear around the circumference of an individual bevel. It could appear in the line-up between abutting pipe ends where the individual bevels had uniform root faces around the circumference, but where one side would be 1/32-in. and the other side would be 3/32-in.

The effect of the allowable root face variation in the line-up could be as shown:

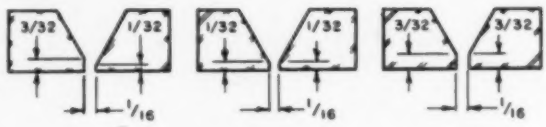


FIG. 6

A welder may encounter some or all of these variations on a single weld as he proceeds around the circumference.

A comparison of the welding procedure and technique applied to a dimensionally uniform line-up and a line-up with dimensional variations will illustrate some of the welding technique changes required by these variations.

With a uniform root face of 1/16-in. and with uniform space of 1/16-in. and with a proper voltage and current setting on the machine, the electrode manipulation required would be a slight changing of the angle as the welder proceeds around the circumference.

A line-up with equal but uniform dimensions as shown here would require that the arc be directed toward the heavy root face so as to avoid burning through the light root face.

A line-up with uniform dimensions as shown here would require less welding current to avoid burn through areas. Another corrective measure to avoid burn through would be to reduce the spacing to 1/32-in.

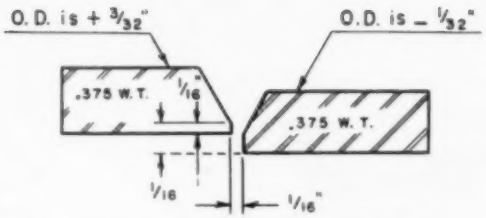
A line-up with uniform dimensions requires a higher current setting to avoid lack of penetration. Slightly wider space will assist in getting penetration for a given current setting.

To summarize, it can be seen that with constant spacing dimension, increased root face thickness requires increased welding current to obtain full penetration. Decreased root face thickness requires decreased welding current to avoid burn through, and that two different root face thickness require a possible decrease in welding current and a change in the direction of the arc.

Effect of variation in space. Where the root face dimension is constant increased space requires less welding current to avoid burn through. Decreased space requires higher welding current to achieve full penetration.

Variation in OD and WT. In order to more clearly show the effect of variations in OD and wall thickness we shall assume that root face dimensions and spacing are uniform and equal 1/16-in. in the following line-up examples.

Variations in OD and wall thickness introduce a condition in the line-up known as Offset or Hi-Low.



Pipe within specifications - yet offset can be 1/8"

FIG. 7

For example, a line-up with one pipe end containing a maximum *plus* diameter tolerance and an adjacent pipe end containing a maximum *minus* diameter tolerance with wall thickness exactly .375 and uniform around the circumference, would produce a maximum offset of ⅛-in. as shown above, if the pipe ends are perfectly round.

For 30-in. OD by .375-in. wall pipe, the allowable variation in wall thickness is 0.338 to 0.431 in. or minus 10 percent to plus 15 percent.

If the OD were exactly nominal, the wall thickness tolerance could introduce offset as shown below.

FIG. 8

It is possible that the OD variations and the wall thickness variations could be additive to increase the offset to approximately 5/32-in.

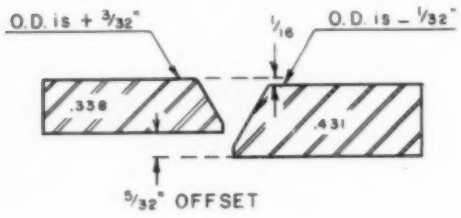


FIG. 9

As the offset increases it becomes more and more difficult for the welder to acquire full penetration and fusion as shown.

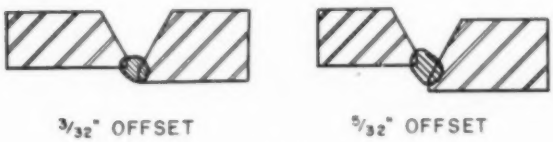


FIG. 10

ASA B31-1 Section 8 — Code for Gas Transmission and Distribution piping systems allows that no special treatment is required for internal offset less than 3/32-in. and external offset less than ⅛-in. Thus, with 3/32-in. internal offset the stringer bead would be acceptable provided full penetration and fusion have been obtained. One method of correcting for defects or offset in excess of 3/32 internally, is to apply an inside weld pass to the joint.

Problems in Stringer Bead Pass

There is no single simple variable that causes internal undercuts in a stringer bead. The actual welding technique and procedure probably has more to do with determining whether undercut will exist than do variations in the line-up although the two are actually inseparable.

From the above it is evident that it is possible for a line-up to contain an almost unlimited number of dimensional variations around the circumference due to manufacturing dimensional variation within specification tolerances.

The skill of the welder is the factor that is called upon to compensate for all of these variations in line-up. It requires constantly changing welding currents, electrode manipulation, etc., in order to produce a sound stringer bead. With the drag technique the welding current cannot be changed readily by varying the arc lengths. For this reason the current is varied by the welder helper, who changes the machine settings at the direction of the welder while running the stringer bead.

The importance of minimizing dimensional variation in a line-up cannot be overemphasized. The better the line-up, the higher the production rate and the lower the reject rate. The more a line-up deviates from uniformity, the greater the skill demanded of the welder, the slower the production and the higher the reject rate.

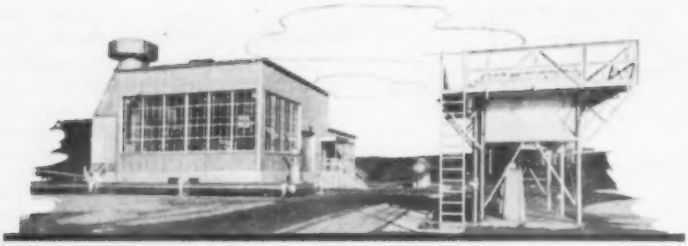
We have shown how pipe can meet all manufacturing specifications and still contribute to dimensional variations in the field line-up. The only combination of dimensional variations that would produce a line-up that probably could not be readily welded without an inside pass would be where OD variations and WT variations combine to give 5/32-in. offset. It would be a rare thing if two pieces of pipe with these variations should by chance be mated for welding. Only a very small percentage of pipe actually fails to meet the dimensional tolerances required. It is worthwhile to emphasize here that pipe line-ups with one side having maximum over tolerance on OD of plus 3/32-in. and the adjoining side having maximum under tolerance of minus 1/32-in. on OD, the maximum offset should not exceed 1/16-in. which is readily weldable. However, this offset of 1/16-in. cannot be achieved unless the two pipe ends are round.

The ability of the line-up clamp to round out the pipe ends is essential if a proper line-up is to be accomplished. The failure of the line-up clamp to round up the ends of the pipe causes excessive offset to be present in segments of the circumference. Hammering on these excessive offsets can produce undesirable notches in the pipe and swaging effects in the joint.

After the line-up, the stringer bead is made. The welder starts at some point near the top of the pipe dragging the electrode downward around both sides of the circumference, completing it at some point near the bottom. **When one welder is used to make the entire stringer bead it is desirable to weld segments of the bead in opposite quarters to avoid changes in spacing in the unwelded segments that might occur due to weld shrinkage stresses. Where two or more welders are making a stringer bead they should weld simultaneously and in opposite quarters. It is usually mandatory that two or more welders be used for stringer beads on pipe 16-in. and larger.**

Electrodes

Class E6010 and E7010 electrodes are used extensively



Perulack station . . . compact home of the turbine driven Cooper-Bessemer centrifugal shown.

Flexibility and high capacity gas transmission with Cooper-Bessemer Centrifugals...

HERE shown is one of the first of the modern Cooper-Bessemer centrifugals to go into operation on the Texas Eastern Penn-Jersey Transmission Corporation pipeline.

Four initial stations are being equipped with Cooper-Bessemer centrifugals, driven by 5000 HP Westinghouse turbines, to take gas from storage in Western Pennsylvania to densely populated areas on the East Coast.

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Adaptable to any type of power unit, Cooper-Bessemer centrifugal compressors are ideally suited to economically handle the most demanding gas pipeline service requirements.

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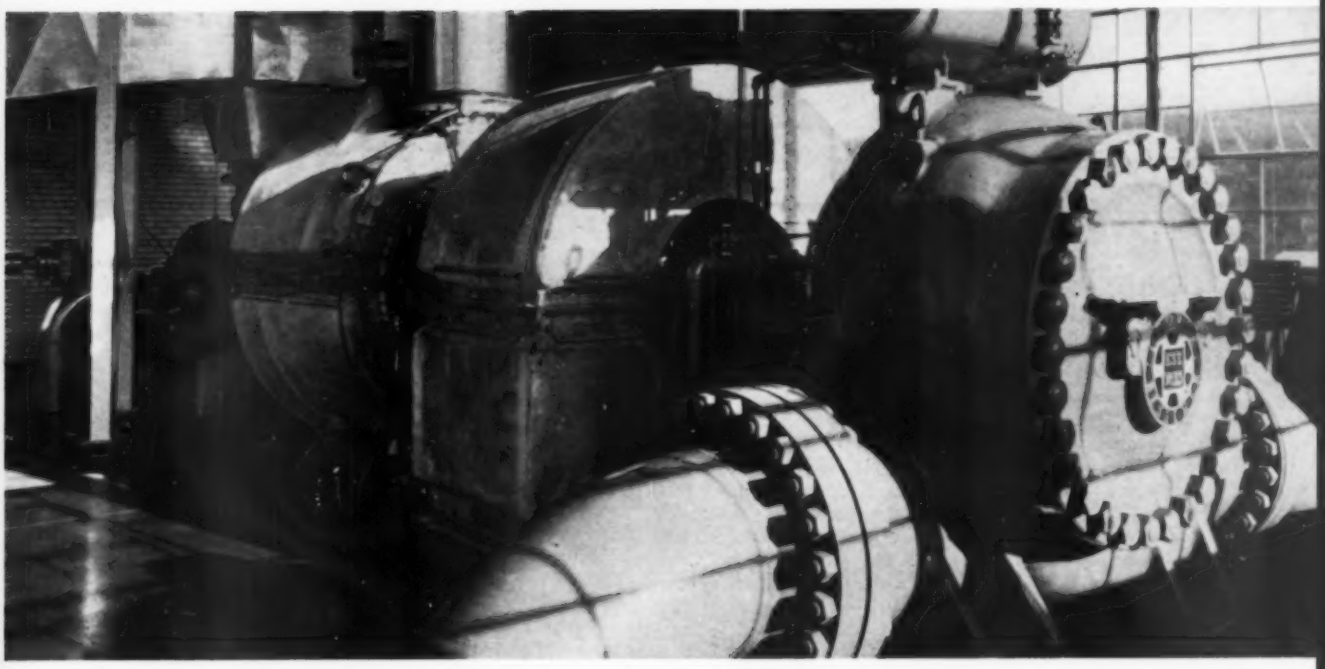

Cooper-Bessemer RFB-24 centrifugal compressor installed in the Perulack, Pa. station on the Texas Eastern Penn-Jersey gas transmission line. This unit is driven by a 5000 HP Westinghouse gas turbine.

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for mild steel pipe welding. The as-welded mechanical properties of these electrodes are:

	Yield Strength	*Tensile Strength*	*El. in 2-in. %*
E6010	52,000 - 58,000	62,000 - 70,000	22 - 28
E7010	62,000 - 66,000	75,000 - 82,000	18 - 25

Recommended amperage ranges for these electrodes are:

Size	*Amps*
1/8	75 - 130
5/32	90 - 175
3/16	140 - 225

When electrodes are operated at currents in excess of the maximum recommended, for any extended length of time, excessive electrode temperatures will cause the coating to breakdown. The first visual indication of coating breakdown is a blackening and smoking of the unconsumed portion of the electrode coating. If welding is continued with the excessive current the coating may burst into flame.

Coating breakdown decreases the effectiveness of the gas shielding of the arc and molten metal and the slag formation. In order to see what affect this has on the weld, we might consider that as coating breakdown becomes more severe the welding process is progressing from a shielded arc process to an unshielded arc process.

A comparison of the mechanical properties of the shielded and unshielded arc weld indicated previously that the unshielded arc weld (bare electrode) possessed considerably lower tensile strength and ductility than the shielded arc weld.

Thus, as coating breakdown progress we should expect the tensile strength and ductility of the weld deposit to be progressively lower.

Because of line-up variations that cannot be eliminated, it is usually necessary to exceed recommended current values for short periods of time when making the stringer bead. Provided the electrode is discarded when there is an indication of coating breakdown, these excessive currents will not seriously affect the mechanical properties of the weld. The actual voltage and current setting used for stringer bead and all other weld passes, will vary with individual welders. However, there is a proper or desirable range of voltage and current settings that may be used for a particular application, and the actual setting within this range will depend on the individual welder.

A normal setting range for stringer bead may be 60 to 80 volts and 155-175 amps with the 5/32 E6010 electrode. Because the burn-off rate of the electrode increases with welding current, it is possible to achieve higher welding speeds by using higher welding currents. However, the latter is apt to cause coating breakdown, resulting in partially consumed electrodes being discarded. The price of excessive current values is an increase in total electrode consumption and possible sub-standard welds.

The Hot Pass

The second weld pass in pipe welding is commonly referred to as the "hot pass." This pass is usually applied using higher welding currents (hotter) than are used on succeeding passes. This insures good penetration into the stringer bead and burns out the stringer bead undercut or wagon tracks, and, at the same time fills in voids or windows.

The stringer bead should be thoroughly cleaned before the hot-pass is applied. An effective tool for this is a power operated wire brush. Also, an ice pick is sometimes useful in digging slag out of the stringer bead undercut. Grinding the stringer bead with a disc grinder after cleaning has two advantages. It provides better access for external undercut cleaning and makes it easier for the welder to burn out the wagon tracks.

Improper cleaning will leave excessive amounts of slag in the welding groove and some of this slag will usually end up as slag inclusion defect in the completed weld.

The welder usually applies this pass using a slight side-to-side weaving motion, so as to alternately aim the arc directly at the external undercuts or wagon tracks on both sides of the stringer bead. Proper technique on the part of the welder will allow any slag trapped in the stringer bead undercut to float to the surface of the molten metal and thus be removed from the weld.

If the welding current is too high, the welder will have to travel at too fast a rate around the circumference and thus, not enough time will be allowed for all of this slag to float out. Excessive current, besides requiring too fast a rate of travel for proper slag removal, will usually result in surface pin holes and a rough appearance of the bead surface. It may also result in coating breakdown as described previously.

Improper hot pass application will result in wagon track defects and possible other slag entrapment and porosity. The electrode commonly used for the hot pass is the 5/32 E7010. Welding voltages and currents are usually in the upper limits of the recommended ranges.

Filler Passes

Filler passes are applied with a 5/32 or 3/16 E7010 electrodes. Welding currents vary with individual welders within recommended ranges.

A slight side-to-side weaving motion is used on filler passes to insure complete filling of the welding groove.

Filler pass defects are usually confined to slag inclusions, porosity and sometimes lack of fusion. Again it is important to properly clean each preceding weld pass to minimize the possibility of slag inclusions remaining in the completed weld.

Porosity is a globular void in the weld which results from chemical reactions occurring during welding. As the weld metal cools certain gases are less soluble in the metal and are released from the metal forming the voids. The ones that do not escape to the surface remain in the weld as porosity. Excessive heat and improper electrode manipulation are generally the causes of porosity in a weld. Defective electrode coatings may contribute to porosity.

Cover Pass

Final pass of a pipe weld should provide a neat workmanlike appearance to the finished weld. The cover pass is usually 1/32 to 1/16 higher than the adjacent pipe wall, and usually overlaps the original groove 1/16-in. on each side. Before applying the final pass, it is sometimes necessary to flush up low areas (usually on the sides of a vertical down weld) by adding bead segments at these areas. This is called "stripping."

Undercutting and surface pin holes are common defects in the final pass. Their cause is primarily poor technique or electrode manipulation; however, defective electrode coating can be a major factor. If the welder holds too long an arc or moves the electrode away too quickly from the sides of the cover pass, undercutting will result. Surface pin holes may be caused by excessive heat and/or improper manipulation of the electrode.

Part 3 will appear in June issue of *The Pipeline Engineer*. It will discuss standards of acceptability, quality control methods, use of preheat, etc.

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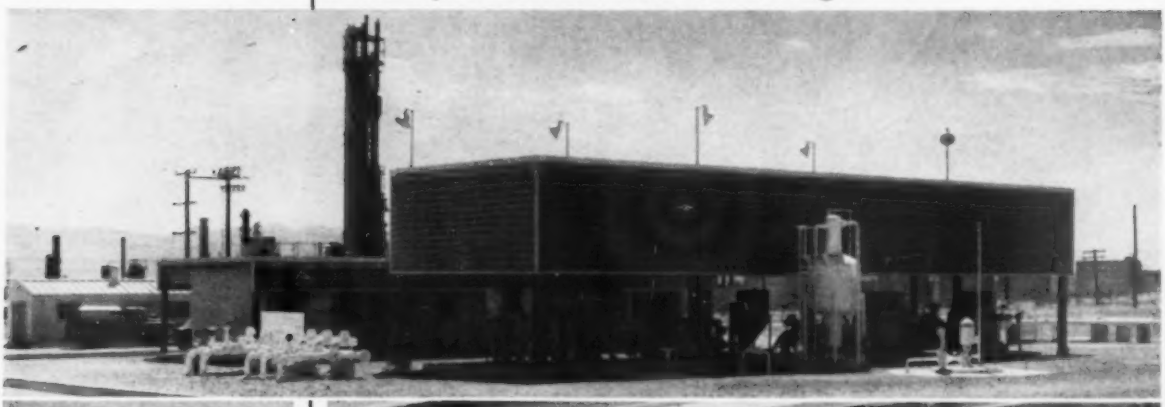

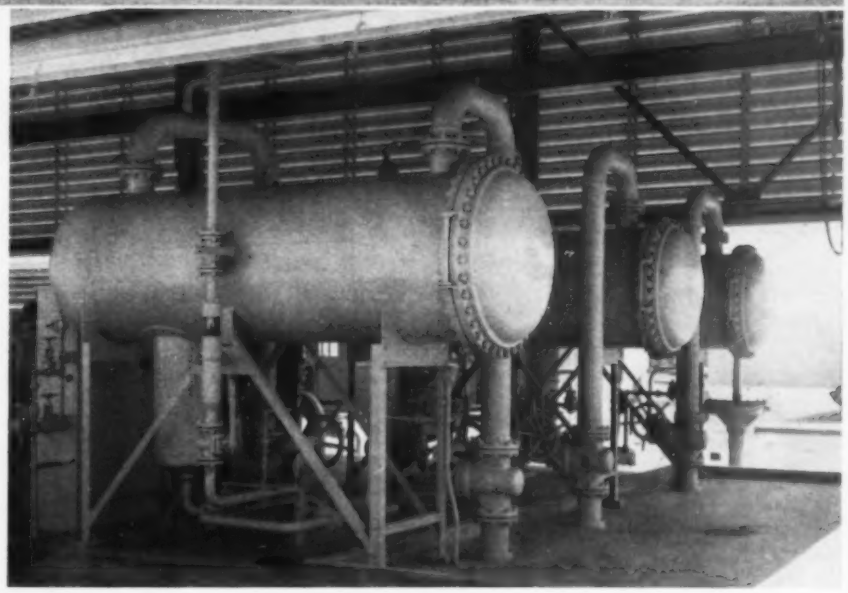

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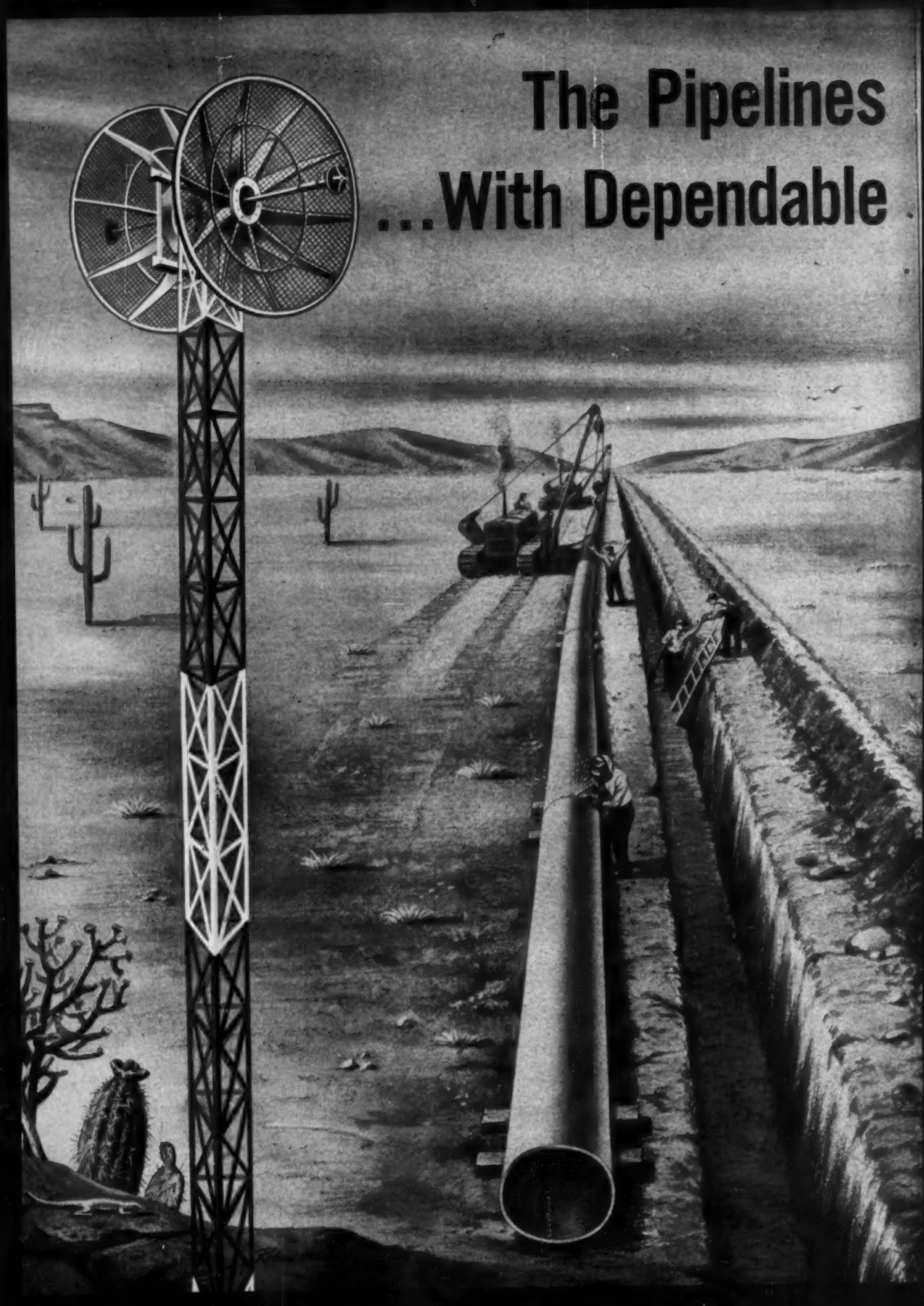
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New master control system for pipelines

Its promises are exciting. It performs like an overriding brain, integrating supervisory controls, data logging, alarm reporting and programming

H. S. Wilson,
Communications System Engineering, Radio Corporation of America

POINT-TO-POINT supervisory control and telemetering of quantities along the pipeline have contributed, in past years, to more efficient system operation. Insufficient use, however, has been exerted until recently on centralized control of many remote points. For example, in a single gas gathering field, 100 to 300 gas wells may feed into a gas transmission system. A low cost method of controlling the flow from a central location is needed.

RCA recently carried out a study of the market and decided to initiate development of a system that would provide centralized control of many points on a party line basis. This equipment when fully developed is planned for use by the oil and gas industry to provide supervisory control, data logging, alarm reporting, and facilities for connection to a computer in one integrated system.

Maximum consideration has been given to a high degree of reliability and error correction features. The master control station design will serve many remote stations by coded signals. The system will use any standard voice transmission facility including VHF radio. The remote station equipment is designed with a building block format, which can be used for any type of controlled location. The master station, constructed in a similar manner, will produce printed records, tape records, or visual display. All control equipment is completely transistorized.

In the case of a gas gathering field, each wellhead will be equipped for remote telemetering and control. At the master control location, the dispatcher will have data log readings automatically typed on a pre-programmed schedule, if desired, and will be able to control the field according to state regulations, customer demand, optimum flow, and minimum production cost.

This system is a party line system. It can program regular operational readings and have station condition reports sent out regularly. If an abnormal condition occurs at a station, the station identifies itself and the operator can then check the status at the station to establish identification of the fault.

The various building blocks can be combined in many ways to provide a variety of control systems. Some of these are as follows:

FIG. 1. Right, typical flexowriter with printed record; left, typical paper tape equipment.

1. Control from a centrally located manually operated flexowriter with paper tape equipment, display board or a combination of these, to many remote locations. (See Fig. 1)
2. Supervisory control systems operating from point-to-point.
3. Fault scanning and reporting systems.
4. Complete control from a central point of many remote locations, using a computer to operate the master control station.

Group Tone Coding Chosen

An important part of the control system is the communication facility used to connect the remote stations with the master station. The signaling used must work effectively over a variety of communication facilities. Of these facilities, VHF experiences the most interference from external noise and abnormal transmission properties from other systems. Tone equipment has been devised that will not trigger on noise 6 db below nominal input signal level. Noise of this magnitude is not expected under the poorest operating conditions on a planned system.

The coding system cannot be susceptible to noise and interference found on any of the commonly used voice facilities. In arriving at the present coding scheme, consideration was given to the use of pulse coding of a single tone, as well as coding using a combination of tones. On the basis of reliability of transmission and simplicity of equipment design simultaneous group tone coding was chosen. Pulse lengths of the tones are long enough to permit integration of the code, thus providing protection from interference signals. A coded tone burst from a single tone or group of tones provides all information for a particular function.

TYPES OF FUNCTIONS PERFORMED BY AUTOMATION SYSTEM

1	CONTROL OPERATION
2	DIFFERENTIAL CONTROL
3	STATUS READINGS
4	TELEMETER READINGS
5	ALARM REPORTING

FIG. 2

The coding scheme requires a total of 10 tone frequencies at the master station to perform 10 functions at up to 100 remote stations. By reducing the number of stations, the number of functions at each location can be increased. An 11th tone common to all stations is used for equipment discipline. Remote stations will require no more than 6 tones, including the equipment discipline tone. Fewer tones are used when a smaller number of stations or functions per station are required. The system is further simplified in that 5 common tones are used for groups of 10 stations.

Length of the tone bursts in most cases will be 100 milliseconds transmitted from the master station and 150 millisecond transmissions from the remote location.

How the Control System Works

The system has been designed to perform functions shown in Fig. 2.

The five basic types of operation (1) to (5) in Fig. 2 can be explained briefly. In the following discussions, the dispatcher is used as the initiation

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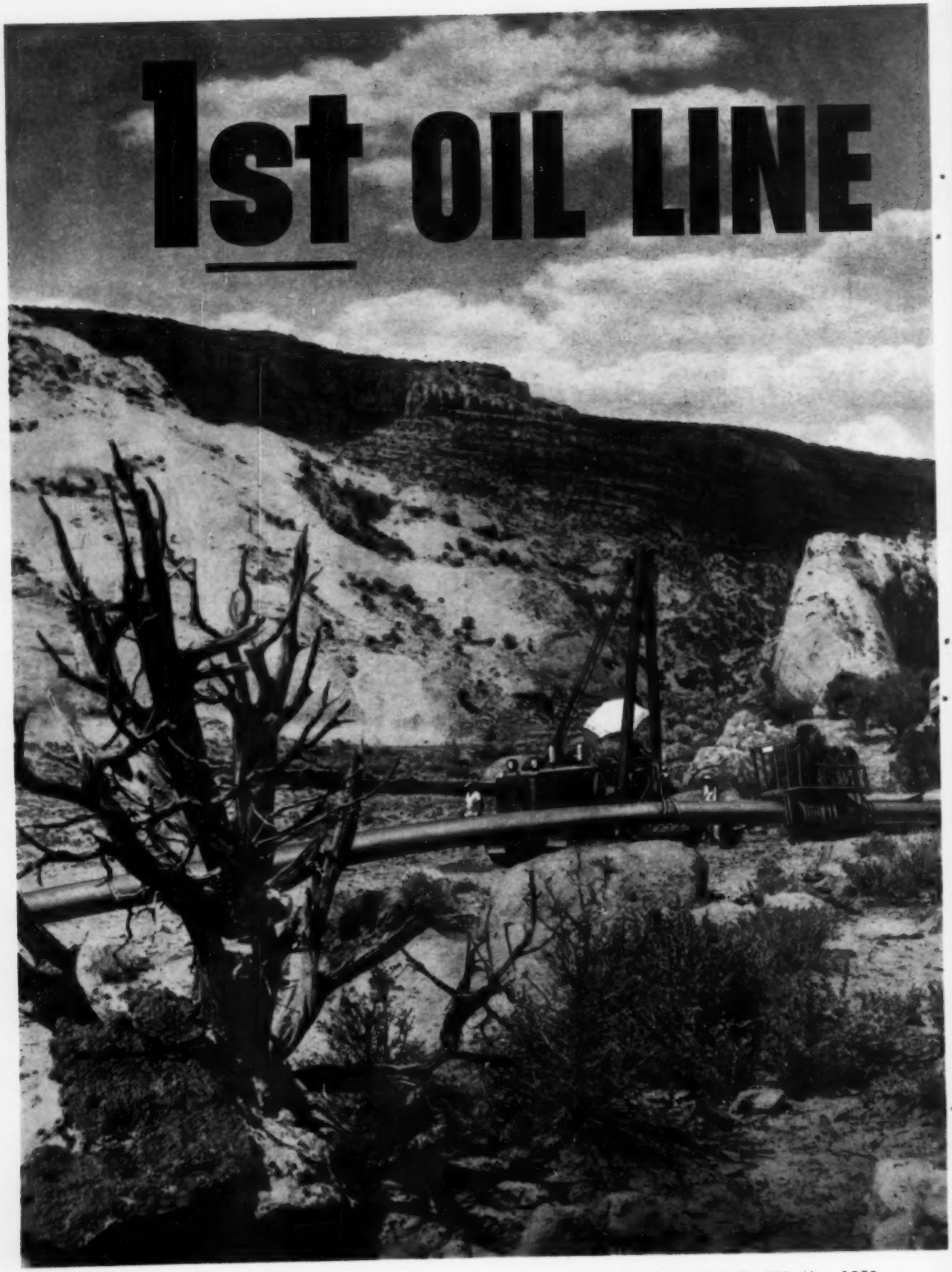

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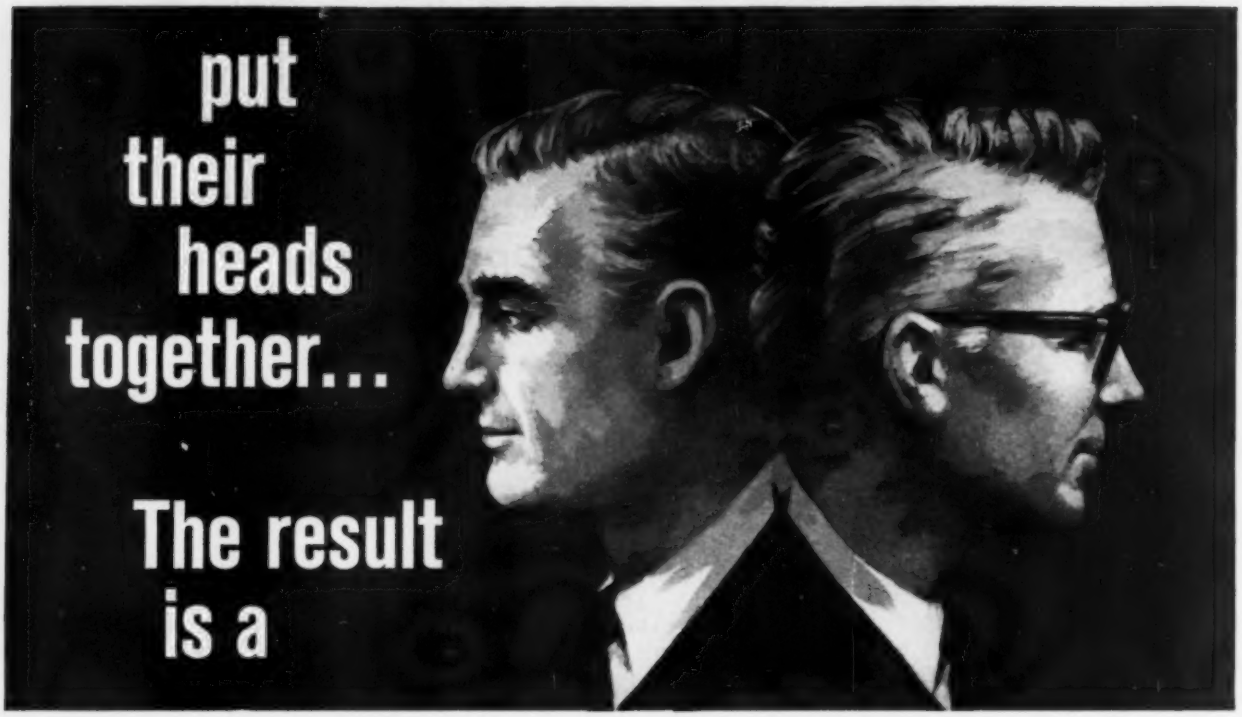
Engineers at Clark and Northern Natural Gas Company



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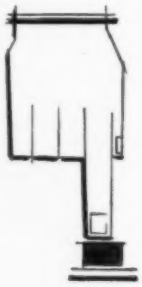

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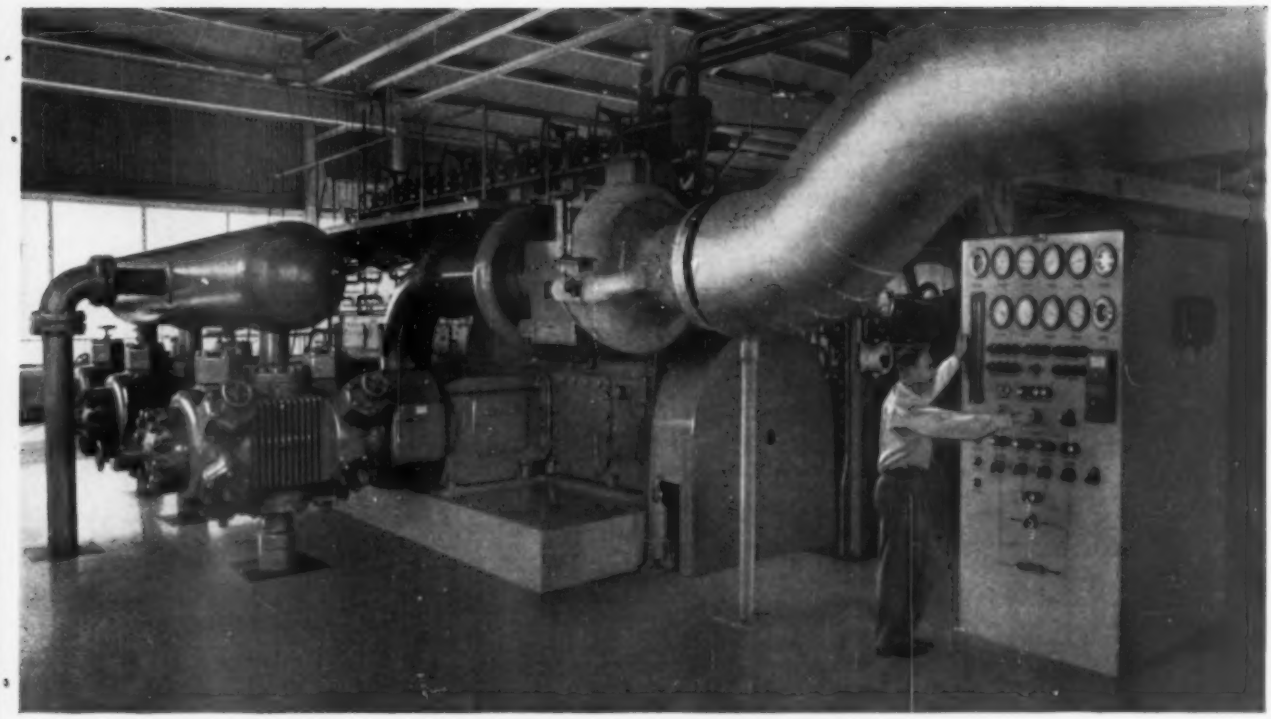

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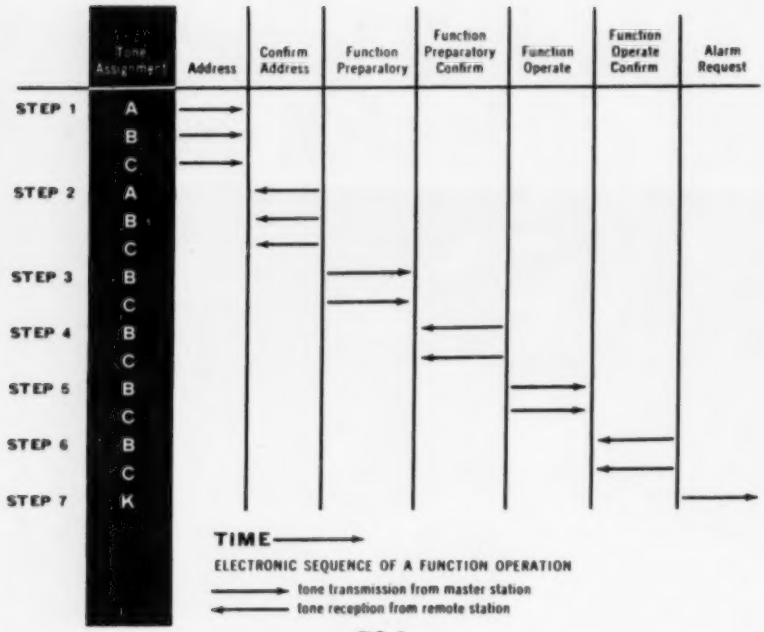

FIG. 3

source for programming and inserting information; however, this function can be performed from pre-programmed paper tape or a computer.

1. **Control operation** (See Fig. 3). Operator first chooses a station address and a particular operation. Both are logged on the typewriter. Station address is then automatically transmitted and confirmed. Operator then keys the operation function a second time as a check. The two-tone operation code is then transmitted and a remote station confirms the operation request.

Immediately upon receiving the confirmation, the two-tone burst is re-transmitted and causes the operation to occur. After the operation is complete, the remote station re-sets itself and simultaneously transmits the same operation code back to the master station to confirm the completion of operation. Finally, the time of day (24-hr clock) is recorded and an alarm request interrogation follows. If any station has an alarm condition, its address is transmitted and printed at the master station.

For an entire cycle of address, operation, and confirmation, the transmission time is one second, the mechanical operations of a flexowriter two seconds, and the operator time is estimated at three seconds. Total time, therefore, is about six seconds per operation.

2. **Differential control.** Many controls require a differential change. In this case the operator will program the station address, function, and percentage change request. He will then actuate a raise or lower button. Address

SELF-CONTAINED EQUIPMENT DISCIPLINE

1. **Individual Automatic Reset**	Remote station resets after each operation as it confirms operation
2. **Station Alarm Indication**	If station fails to reset it answers master station request for alarm
3. **Auto-Alarm Feature**	System may be set for automatic alarm monitoring during no-traffic period
4. **Switch from Dormant to Alive**	Stations may be activated for operation with 100 millisecond tone transmission
5. **Station Kill**	If equipment fault occurs, station may be turned off
6. **Transmitter Quiet**	Where VHF is used remotely, equipment protects against a too long transmission

FIG. 4

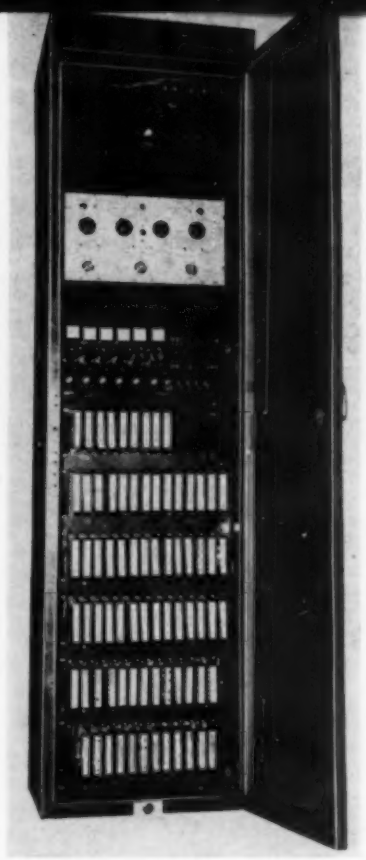

FIG. 5. Engineering model of typical master control station. Top portion contains transistorized plug-in circuit boards.

and confirmation will follow. Operator will again press the function button and two tones will be transmitted. A two-tone confirmation will be returned. Once confirmed, one of the two tones will be transmitted for a period that will represent a percentage of full scale change. Full scale change may be a 5 or 12 second tone signal. One tone will be used for "raise" while the other will be used for lower. A two-tone "operation complete" signal will be returned. The slave station resets. The master station then transmits an alarm request.

3. **Status readings.** The master station may be programmed to give a preset series of status readings by actuating one control function. The remote station address will be inserted and will be followed by actuation of the status reading button. Return conditions of "on" or "off" control will be printed if a typewriter is used or will confirm the conditions on a display board. After status transmission, the remote station resets. The master station transmits an alarm request.

4. **Telemeter readings.** In this case, the address is followed by the two-tone burst transmission. This causes the slave station to transmit one or more telemeter readings in sequence. A modified Bristol or Foxboro type impulse telemeter can be used. For example, a

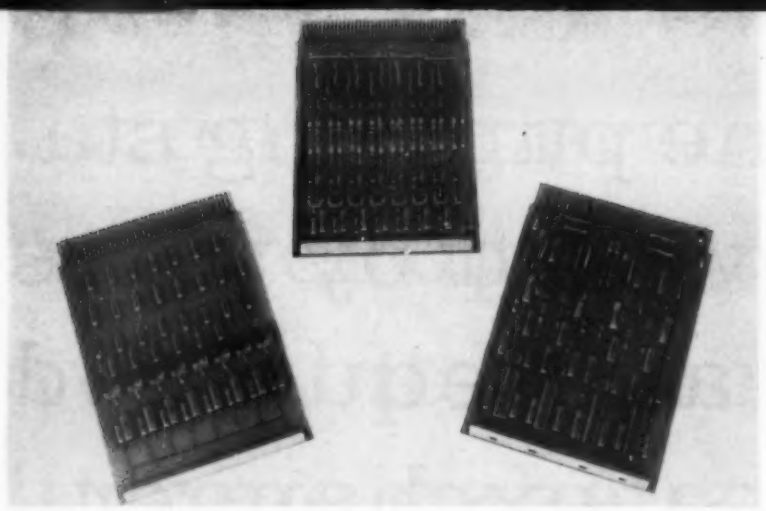

FIG. 6. System employs three basic types of transistorized plug-in circuit boards.

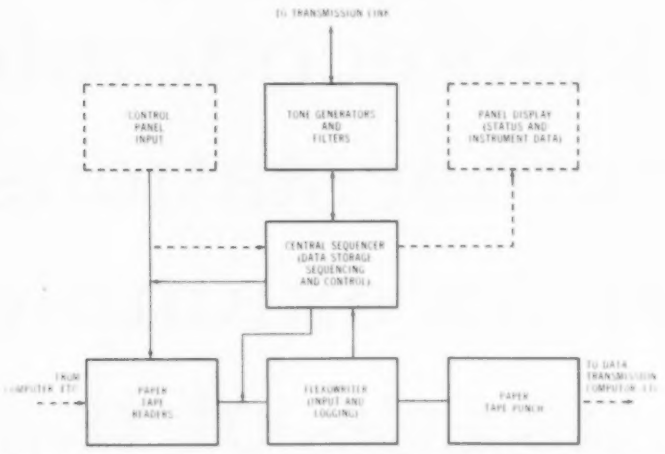
TO TRANSMISSION LINK
CONTROL PANEL INPUT
TONE GENERATORS AND FILTERS
PANEL DISPLAY (STATUS AND INSTRUMENT DATA)
CENTRAL SEQUENCER (DATA STORAGE SEQUENCING AND CONTROL)
FROM COMPUTER ETC.
PAPER TAPE READERS
FLEXOWRITER (INPUT AND LOGGING)
PAPER TAPE PUNCH
TO DATA TRANSMISSION COMPUTER ETC.

FIG. 7. Functional block diagram of master control station controlled by flexowriter.

12-second cycle may be used for each reading. One of the two tones will transmit a 1 to 11 second pulse to indicate percentage of full scale value. These readings may be data logged or indicated on appropriate meters or charts as required by the particular installation. No signal during any 12-second interval will produce an alarm condition.

5. **Alarm reporting.** During traffic periods, alarm indications can be obtained as follows:

1. By the standard status read operation for each station.
2. All call interrogation for alarm report after each operation function or by manual insertion.

The first condition already has been discussed. The second is a special one-tone signal from the master station. Earlier in this article, reference was made to use of one additional tone common to all stations. This tone will be transmitted after each function to request an alarm report.

This call is sent out by the master station as a request for any remote station that has an alarm condition (which includes station non-reset) to report its presence by transmitting its three-tone address call. If an alarm exists, a status reading can be taken of the particular remote station to locate the particular alarm condition.

Equipment discipline functions. In addition, adequate equipment discipline must be provided for maximum system reliability. These functions are shown in Fig. 4.

Station Description

Master station. Since the operations performed by the system are initiated from the master station, (See Fig. 5), and all system information obtained is received there, this equipment must be responsible for sequencing all operations, checking their correctness, detecting failures, and enforcing the system discipline needed to insure safety and efficiency. Because of this, the sequencing and control equipment represents an important part of the master station equipment complement.

The sequencer is completely transistorized and constructed of a small group of standard circuits, groups of which are constructed on printed wiring plug-in circuit boards. These circuit boards can be pre-tested individually. Most of the switching and control circuits are made up of three basic transistorized circuits. (Fig. 6). Plug-in type construction makes it relatively simple to fabricate a sequencer specially tailored to a particular customer's needs, since the only new thing to be fabricated is the wiring together of the circuit board receptacles. Even this can be minimized since the wiring of each sub-block can be standardized and manufactured in advance so that a system layout would consist of the assembling and wiring of sub-blocks. The plug-in circuitry, of course, facilitates trouble shooting and repair since repair would usually consist of the replacement of a defective plug-in board with a pre-tested operable one.

Should the equipment be used with a flexowriter, the system may do the following: (See Fig. 7.)

1. Initiate operations by sending electrical signals to the central sequencer.
2. Respond to manual input via its keyboard or electrical input obtained either from paper tape reader output or the central se-

Continued on Page D-74

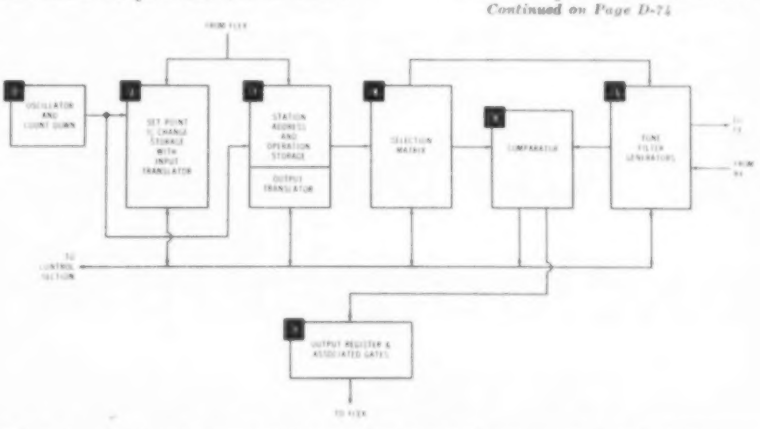

FIG. 8. Functional block diagram of data handling section of master control's central sequencer.

A pipeline pumping station—powered by a gas turbine and equipped with a heat exchanger—has a decided economic edge over other stations. Manpower, for example, is as little as 20% of that needed by stations powered by diesel, steam or gas engines.

What part does the heat exchanger play? If it's an APCO extended sur-

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face regenerator, it can recover up to 80% of the available heat in the gas turbine exhaust . . . and thereby cut fuel by 30%.* What's more, it takes less than 500 manhours to erect a unit on a 5000 hp cycle. Maintenance needed thereafter: zero For details, contact:

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(Continued from page D-47)

tribution of demand are considerable and unpredictable.

There is also the vital function of controlling the extraction of gas from a company's various well holdings. This is managed by local dispatching offices which are adjuncts to the chief dispatch office. Such extraction is restricted by limits imposed by lease terms and by demand reflected into the field from the receiving end of the line. Wellhead valves are manually operated and metered by gagers, who submit gage tickets periodically in handwritten form.

The many factors involved in transporting gas from wellhead to consumer make it virtually impossible to decide analytically the most efficient mode of operation. The complexity of interaction between the many variables puts control decisions beyond the capacity of human judgment. As a consequence, successful dispatch operations depend upon the skill and experience of the chief dispatcher.

Some of the most competent dispatchers, in handling modern extensive transmission pipeline networks, are finding that as their systems expand, so do control problems. Increasing complexity is putting them in a position of being unable to maintain their old accustomed "feel" of optimum operating conditions.

In a similar manner, the dispatchers for the gas supply field are experiencing more difficulty in programming the draw-out from their lease holdings as new wells are added to their networks.

Due to insufficient means for extracting the significant portions of the data now fed into the chief dispatcher's office, more recorded data are accumulated than necessary. Valuable skilled man-hours are wasted in scanning and summarizing this large volume of data.

Several automatic features are already in use by various pipelines. Principal ones are:

1. Automatic sequence-control for compressor start-up and shut down: "One push-button" operation
2. Automatic speed control of compressors: Deviation of discharge pressure adjusts speed to return this pressure to a predetermined set-point
3. Automatic telemetering of monitor data with print-out. This can be for any type of variable desired
4. Automatic flow computer giving direct volume-flow readout
5. Automatic surge prediction and control.

Additional automation is needed for integrated control. This includes:

1. Direct central control and operation of all compressor stations
2. Automatic calculation of flow conditions upon which control decisions and orders are based
3. Integrated data communications system to link all automatic functions.

Stanford Research Institute engineers believe that successful development of methods and equipments to combine the above elements is possible. Such an integrated control system could be constructed so that output demands and line status records would be fed into a central control device to operate all compressor stations at optimum efficiency. The control device would consist of a computer capable of receiving and evaluating all input data to decide what action to take. The machine also could calculate the new conditions necessary for changes, and send control signals to the appropriate stations. By feedback of the normal line status records, the machine would ascertain that its orders were carried out and would monitor for troubles.

However, the problems of compos-

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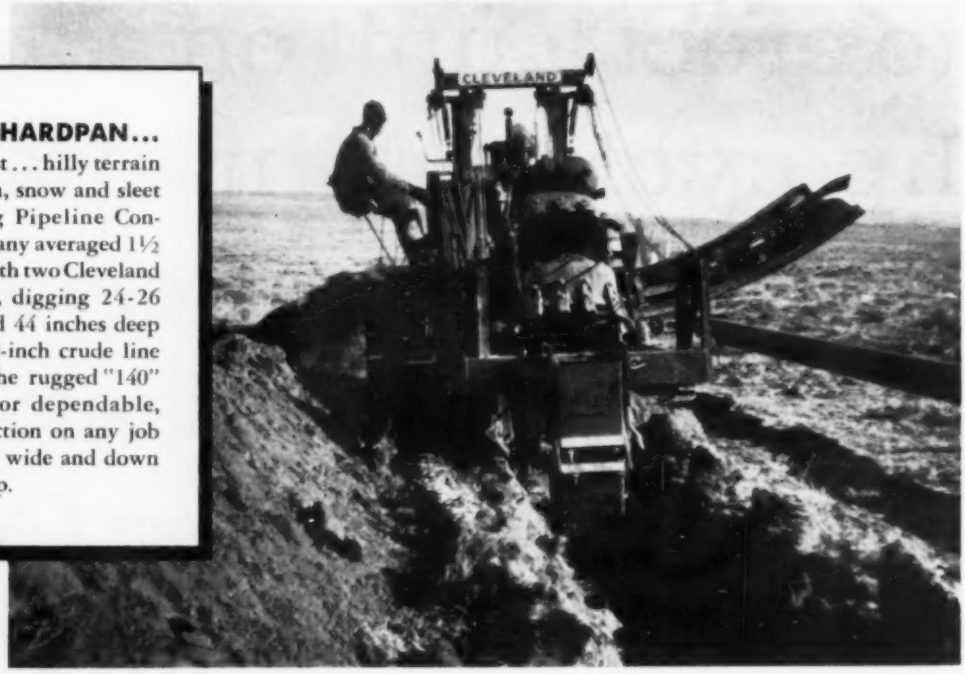

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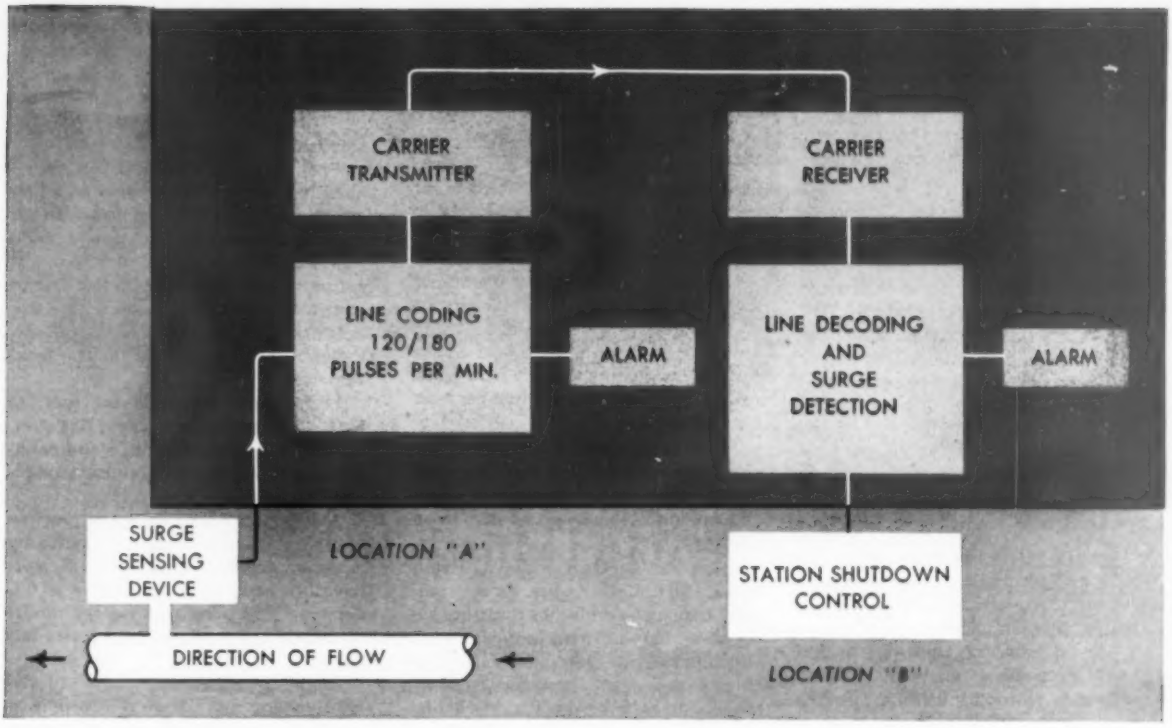

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AUTOMATIC SHUTDOWN

The schematic diagram of the Union Surge-Purger Control System is shown above. Normally the equipment at Location B receives a steady 120-cycle code.

A severe surge causes this code to change to a 180-cycle "shutdown" code. The station shutdown equipment responds *only* to this special shutdown code, immediately acts to shut down the pump upstream from the point where the surge was detected.

If the "normal" 120-cycle code is upset by noise or equipment failure, an alarm indicates this situation. But only a surge can cause a shutdown.

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ing such a system cannot be underestimated. Integration presents a number of challenges. In the area of communications alone, a few of these are noteworthy:

1. No standards exist for electronic control signals. Although all electronic elements exist, in many cases they cannot be interconnected without inefficient conversion equipments.
2. The reliability of low-capacity communications systems designed for private users is too low for on-line operation. This is particularly true of present microwave systems. Failure of equipment to meet minimum downtime specifications has been a major factor in the reluctance of many managements to accept electronic control devices.
3. Analog data transmission is very slow. Equipment now available for digital data transmission is faster than analog in the low-speed ranges, far too fast in the highest speed ranges, and without provision for medium speeds.
4. Automatic message switching equipments are generally tailored for systems far larger than those contemplated here and are operable only with low-speed transmissions.

All the necessary separate physical elements exist for an integrated automatic system to control the operation of a natural gas pipeline. These elements must be combined into a practical operating system in which a performance change can be computed instantly. This would permit control before any effects of the change are experienced. A workable mathematical model of compressible-fluid pipeline operations must be developed to enable a computer to act as the central controller. Such a model is focal in the system because it allows line-performance prediction.

Study being carried out at SRI and elsewhere indicates that there are available — or under formulation — suitable models usable by computers in on-line operation.

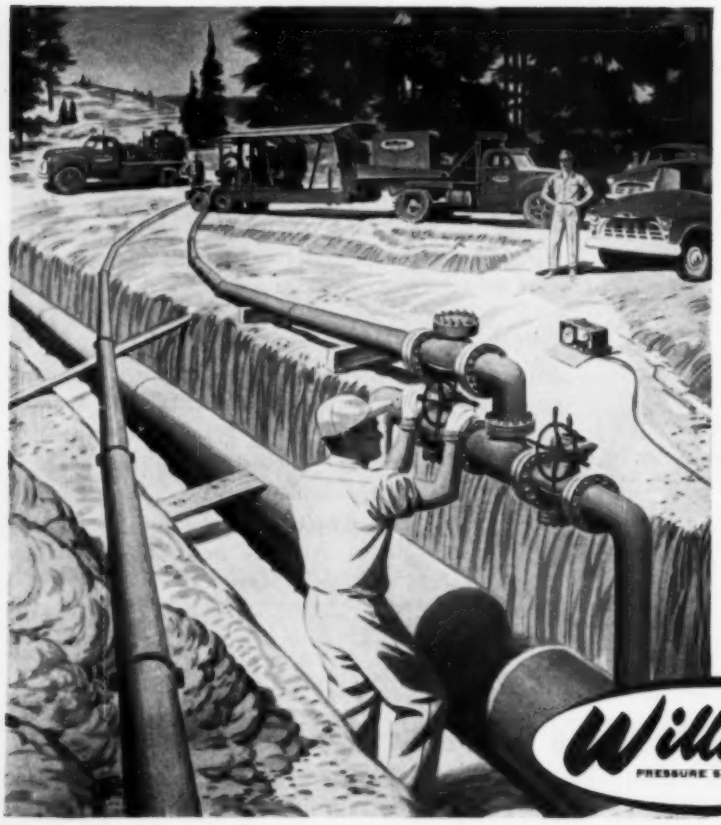
Study done by Dr. George W. Evans, of the SRI mathematics group, indicates that such conditions probably can be met by a small-to-medium-size electronic digital computer. This machine would calculate results from the model for each segment along a line. (A segment is defined as a length of pipe between compressor stations.) Apparently computations could be done fast enough to allow on-line use. There appears to be sufficient time for adjusting calculations to compensate for any errors caused by assumptions in the sectional model. Such adjustments might be effected automatically by successive recalculations of the results.

For integrated control it is conceivable that both transmission and gathering calculations could be done with the same mathematical model and computer. However, the complexity of the gathering problem might dictate that its control be handled separately, the two networks being linked together only by the input requirements of the transmission system.

Preliminary investigations indicate that the gathering problem is one principally of inventory control and could be solved by linear programming or related techniques.

A full model describing the pipeline as a whole is now being formulated by a major pipeline contractor. Results have not been published, but it is understood that programming the model on a large electronic data processor has begun.

Until such models are fully tailored for pipeline use, human decisions – aided by semi-automatic calculations – would supplant the full automatic feature of the computer at the central control office. ★ ★ ★



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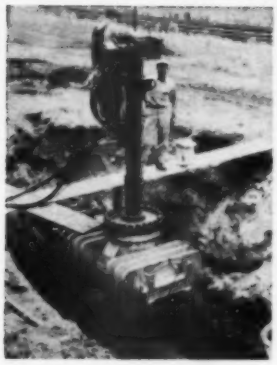

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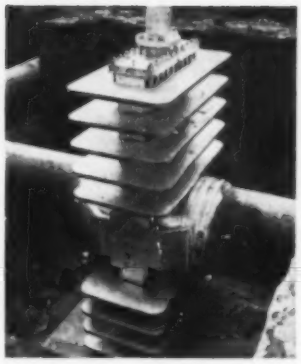

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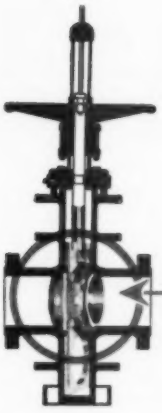

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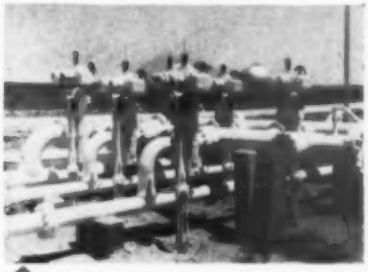
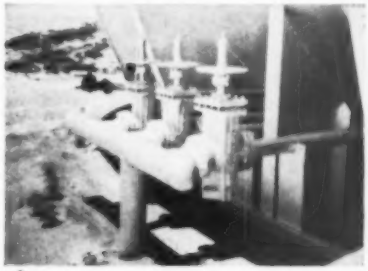
When valve is full open or closed, bubble-tight seals on both sides of the gate completely isolate line pressure in the conduit. The body, serving merely as framework for operating mechanism and to prevent loss of product while gate is in motion, may be drained or vented to atmosphere when gate is open or closed. Integrity of seals can be checked any time by a tell-tale valve on the body.

703



Products manifold at pipeline station illustrates typical motor-operated *Seal-O-Ring* Valve application.



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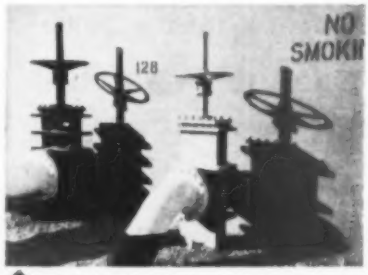

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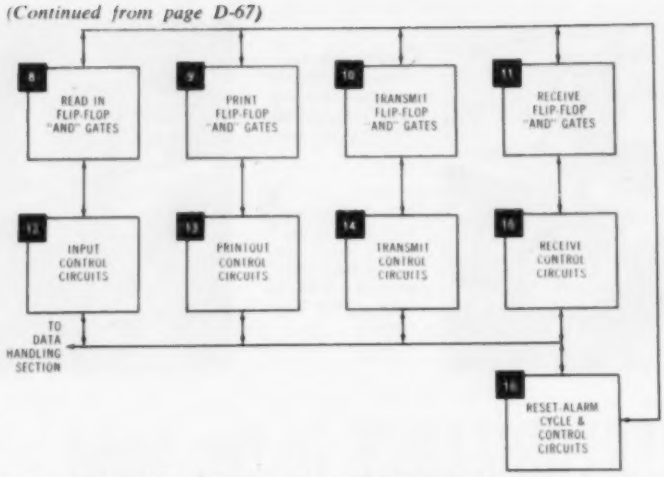

FIG. 9. Functional block diagram of control section of master control's central sequencer.

quencer. This electrical input may be received from a computer in future systems, as the parallel binary decimal code used is compatible with such operation.

3. Punch a paper tape, which can be used as a record of operations, record data, and also a log of operations performed.

Paper tape readers store paper tapes on which are punched previously prepared operation instructions. These instructions may be used intermittently with manual operation to relieve the operation of routine repetitive work, or a long period of operations can be controlled completely by the paper tapes. In operation, the central sequencer requests each paper tape character when required. Fairly elaborate programs can be worked out using two or more tape readers since we have the ability to search a tape for particular codes.

Paper tape punch can punch all operation steps down on the flexowriter or can be called in selectivity to punch. The punch can be operated "on line" while system operations are being performed, or "off line" to prepare tapes for later use without affecting the control system while this is being done.

The master sequencer assures that all steps of an operation are done properly. Steps needed to perform an operation depend on type of operation, number of stations and controls in the systems, and degree of checking considered necessary.

Fig. 8 shows a block diagram of the data handling section of the central sequencer. Block 1 stores the address and operations codes. Block 2 stores the percentage change required in differential control. It is used with block 3 to control the width of the transmitted raise or lower pulse. Block 3 provides timing pulses for differential control operation. Block 4 decodes the output of registers in block 1 and selects tones for transmission. The output is also stored in the comparator block 6 for information of received tones. Block 5 contains the tone filter generators. Block 7 stores all data to be printed on the flexowriter.

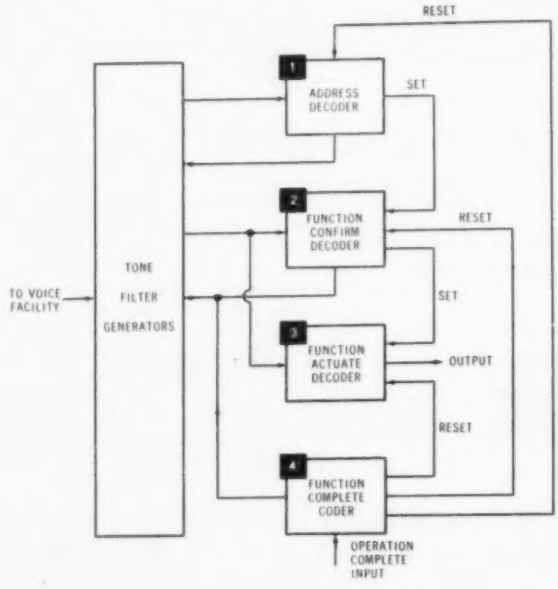

FIG. 10. Functional block diagram of single function remote station.

Fig. 9 is a block diagram of the con-

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trol section of the central sequencer. Read in, print, transmit, and receive flip-flops (blocks 8 to 11) determine the one of four states that the master station is in during the operation. Sequence of these states determines operation of the master station and is fixed by input gates to the four control flip-flops. Once the equipment is in one of the above states, the control circuits (blocks 12 to 15) of that particular state go through a fixed routine, which is ended with a reset pulse to the control flip-flop involved.

Remote station. Remote station equipment complement has been designed to contain as few components as possible per function consistent with maximum system reliability.

Fig. 10 is a simplified block diagram for a single function at a remote station. Each block within the diagram must be set by the previous block before it will accept orders from the tone equipment. First the three-tone station address enters the address decoder. This block provides confirmation of the address to the master station and sets block 2. The two-tone operation code then enters block 2, operation "confirm" is transmitted, and block 3 is set. The same two-tone code is received a second time and provides an output from block 3. When the operation is complete, block 4 returns the "function complete" code and resets blocks 1, 2, and 3.

Uses Are Many

The system is quite flexible. It can be assembled in many arrangements to provide control systems for:

a. Gas-gathering fields.
b. Oil pipelines.
c. Power utilities.
d. Chemical process plants.
e. Factory assembly.
f. Material transfer.

It combines control data logging, alarm reporting, and various programming techniques in a single integrated system.

Also, it can be cordinated with minimum additional equipment into customer computer facilities.

Transmission speed of this transistorized system is almost entirely dependent on the characteristics of the tone units and the mechanical delays introduced by end devices. Applications requiring greater speed may be handled with only a change in the tone equipment.

Note: This control system is currently in an advanced stage of development by RCA's Industrial Electronic Products advanced development activity. Extensive operational trials in the field are contemplated in the near future. * * *

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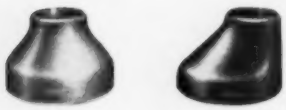

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Canadian News Notes

Northwestern Utilities To Spend $6,500,000

The 1958 gas pipeline construction program of Northwestern Utilities, Ltd., will involve capital expenditures of $6,500,000, according to announcement by General Manager M. E. Stewart. The major part of the program, costing $3,820,000, will be the main line from the Pembina oil field to Edmonton, announced previously. Work is now in progress under contract to Mannix Company, Ltd. The line will carry 65,000,000 cu ft a day of residue gas now flared in the field, to Northwestern's city distribution system lines in Edmonton.

The company also will extend its local distribution lines to five towns in the southeastern and east central parts of Alberta.

Alberta Gas Gives Details on Projects

Details of its remaining 1958 contracts have been reported by The Alberta Gas Trunk Company, Ltd., following award of the principal construction contract in its current program: 114 miles of 24-in. line running northeast from the big Pincher Creek gas field.

The next major item involves 50.2 miles of 34-in. line joining the end of the 24-in. line with the present terminus of the 34-in. main line near Bindloss Junction to the east. The second big job is 24 miles of 26-in. extending northwest from the junction of the 24-in. and 34-in. lines, to receive gas from the Steveville and Cessford fields.

Two small laterals will be let also. To tie in the Sibbald field on the eastern edge of the province, 11 miles of 6-in. will be built to join up with the present 18-in. main, which runs south from the Provost field. The Atlee-Buffalo field will be connected to the 34-in. main by a short 5-mile 6-in. lateral.

Saskatchewan Closes Construction Bids

Saskatchewan Power Corporation closed bids on April 1 for the major items in its 1958 construction of natural gas pipelines.

The largest unit comprises the main line from the Steelman oil field, where a large residual gas conservation plant is being built, to Regina, and an extension of the existing main line from Moose Jaw to Regina. The first part is 124 miles of 10-in. and the second 38.2 miles of 12-in.

The second unit is the main line from the Hatton gas field, on the west edge of the province, to the Success field, where it will tie in with the existing main line. This requires 88 miles of 14-in. and 3.5 miles of 16-in.

The third group comprises the gathering system and the wellhead hook-ups for the Hatton field. This includes 5.6 miles of 8-in., 3.5 miles of 6-in., 2.5 miles of 4-in. and 13.2 miles of 3-in.

On the Alberta side, SPC is to build two more units to provide gathering facilities in the Many Islands gas field, adjacent to and part of the same reservoir as the Hatton field. The first portion is the main gathering line, containing 4.5 miles of 16-in. and 17.5 miles of 10-in. The second part is the subsidiary gathering system, including wellhead hook-ups, comprising 3.6 miles of 8-in., 2 miles of 4-in., and 12.5 miles of 3-in.

A single mile of 16-in. pipe also has to be laid across the provincial boundary, to satisfy dominion law relating to the movement of gas interprovincially. This link between the two provinces will be owned and operated by a subsidiary company with a federal charter. Permission for the transmission of this gas has been obtained from the Board of Transport Commissioners.

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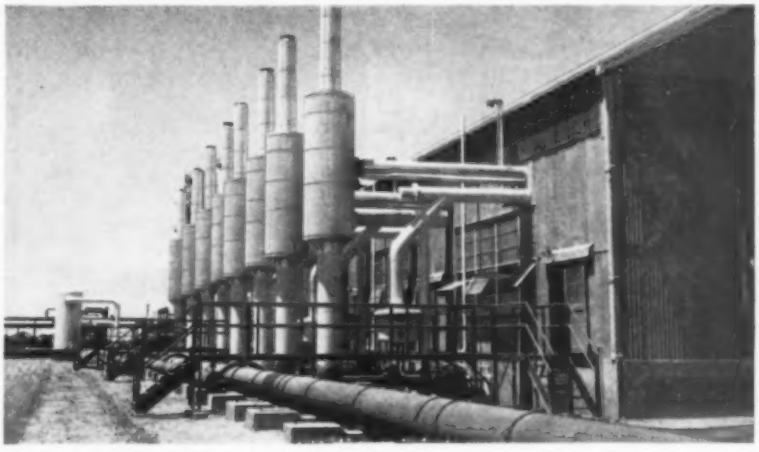

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WITH THE PIPELINE CONTRACTORS

● **Mannix Company, Ltd., 737 Eighth Avenue West, Calgary, Alberta.** Has 93 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* from a point 30 miles west of Hearst running to Kapuskasing, Ontario. Right of way clearing is being completed and pipe laying is to begin between May 15 and June 1. Has 50 miles additional work for *Pembina Pipeline Company*. This is a continuing contract with Pembina, of which 500 miles have now been completed since 1954. Has 45 miles of 16-in. gas transmission line from Pembina field to Calmar, Alberta, and 47 miles of 4 to 16-in. gas gathering lines in Pembina field for *Northwestern Utilities, Ltd.*; one 16-in. river crossing of the North Saskatchewan River is included in this project.

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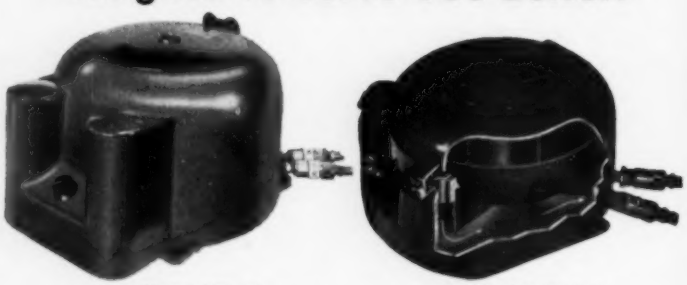

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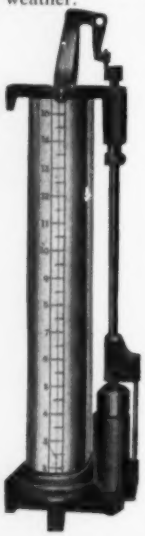

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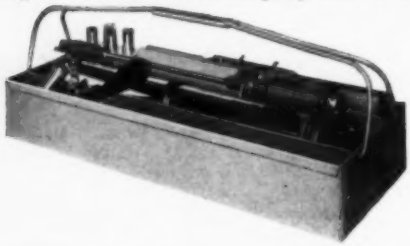

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● **Canadian River Construction, 580 Hornby Street, Vancouver, British Columbia.** Has contract on Spread Y, containing 91.3 miles of 30-in. gas line from Longlac to MP 584.8 at the east bank of the Shekak River for *Northern Ontario Pipe Line Crown Corporation.*

● **Piggott Construction, Ltd, Calgary, Canada.** For *Interprovincial Pipe Line Company*, 82 miles of 24-in. loops in Alberta and Saskatchewan. For *Alberta Gas Trunk Line Company*, 145 miles of 24-in. from Pincher Creek field to Princess Junction, Alberta.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Alberta.** Has 57 miles of 30-in. line for *Trans-Canada Pipe Line*. Has contract for 80 miles of gathering lines for *Westcoast Transmission Company's* natural gas grid system in the Peace River region; plans call for laying some 20-in. as an extension to the main line and also smaller diameter lines down to 6-in. for the Blueberry field.

● **C. P. Bartley & Son Pipe Line Construction, P. O. Box 616, Tioga, North Dakota.** Has 121 miles of 2 through 12-in. gas gathering extensions for *Signal Oil & Gas Company* in the Newton, North Dakota, area.

● **G.E.T. Construction, Inc., 435 S. 116th St., Milwaukee, Wisconsin.** Has 46 miles of 24-in. loops in Wisconsin and Illinois for *Michigan Wisconsin Pipe Line Company.*

● **Four Way Company, Farmington Hwy., Aztec, New Mexico.** Has contract to lay 16-in. line for *Texas-New Mexico Pipeline Company*, for a distance of 150 miles southeast from the Aneth field in Southeast Utah.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **F. E. Shaw, Ltd., 530 S. Vidal Street, Sarnia, Ontario.** Has 40 miles of 6 to 10-in. line for *Dominion Natural Gas Company, Ltd.*, in the Brantford, St. Catharines, and St. Thomas districts. Has 67 miles of 6 to 20-in. transmission lines for *Union Gas Company*, Chatam, Ontario, to Dawn, London, St. Marys, Stratford, Kitchener and Guelph.

● **Lone Star Pipe Line Constructors, Inc., 10301 Shady Trail, Dallas, Texas.** Has 143 miles of 20-in. crude line between Teague and Houston, Texas, for *Sinclair Pipe Line Company.*

● **Oklahoma Pipe Line Constructors, P. O. Box 13227, Dallas 20, Texas.** Has 100 miles of 30-in. for *Creole Petroleum Corporation* between Temblador and Caripito, Venezuela; this is the company's first Venezuelan venture since 1944. Has 50 miles of 22-in. loops for *Portland Pipe Line Corporation* and *Montreal Pipe Line Company;* 39 miles in U. S. and 11 miles in Canada. Has 90 miles of 30-in. (known as Spread 14) for *Trans-Canada Pipe Lines, Ltd.*, from Toronto, Ontario, northward.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 miles 20-in. crude line for *Socony Mobil Oil Company de Venezuela.* Line will extend from San Silvestre field to

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Contractors

Puerto Cabello on the Caribbean Coast. For *Laurel Pipe Line Company*, 106 miles of 14-in. from Aliquippa station, Pennsylvania, to Cleveland, Ohio.

● **Hunsaker Trucking Contractor, Inc., P. O. Box 97, Carrollton, Texas.** Has stringing contract for 90 miles of 16-in. line between DeLeon and Hawley, Texas, for *Humble Pipe Line Company*.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has approximately 20 miles of 12-in. natural gas line for *United Gas Pipe Line Company* near Moss Point, Louisiana. Has approximately 43 miles of 12-in. and smaller natural gas line for *Southern Natural Gas Company* southeast of New Orleans, Louisiana; this is a lay barge and quarter boat operation.

● **O. R. Burden Construction Corporation, Box 5216, Tulsa, Oklahoma.** Has 90 miles of 16-in. for *Humble Pipe Line Company* from Humble's Comyn station in Comanche County to its Hawley station in Jones County, Texas.

● **E. K. Aldridge & Sons, Inc., Box 1324, Athens, Georgia.** Has 60 miles of ¾ to 4-in. line from Reform to Vernon, Alabama, for *Lamar County Natural Gas Authority*.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has 26 miles offshore trenching for the *CATC Group* from Grand Isle, Louisiana, to a point 26 miles out into the Gulf of Mexico. Marine Gathering Corporation is the prime contractor, and Collins is burying the line being laid by Marine Gathering's pipeline barge. Has trenching contract for 57 miles of 12 to 26-in. lines running from shore to offshore facilities at Cameron, Louisiana, for *Tennessee Gas Transmission*. Has contract with *Accra-Mobil Overseas Oil Company* for 11,500 ft of 12-in. sea-loading line from shore at Accra, Ghana (Africa) to a depth of 50 ft. Also has 32,000 ft of 24 and 12-in. sea-loading line for *American Independent Oil Company* at Kuwait into the Persian Gulf. Has trenching contract with *Commonwealth Oil Company* for 10.6 miles of 12-in. offshore line in West Delta block in Gulf of Mexico.

● **Western Pipe Line, Inc., 1011 San Jacinto, Austin 66, Texas.** Has 94 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Hawk Lake and Hyndeman, Ontario.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has contract for the 70.9 miles, 30-in. Spread X of *Northern Ontario Pipeline* between Beardmore to Longlac, Ontario. Has undetermined amount of gathering system for *Producers Pipeline Ltd.* in the Estavan, Saskatchewan, area. Has contract to lay city distribution system in Cooksville, Ontario, for *Consumer Gas Company*. Has city distribution system in Guelph, Ontario, for *Union Gas of Canada*. Has contract for testing *Trans-Canada Pipeline's* line from Alberta to Winnipeg, Manitoba.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has undetermined amount of various size pipe to lay for *Pacific Northwest Pipeline Company* for gathering system in Four Corners area. Also has undetermined amount of gathering system line for *El Paso Natural Gas Company* in the Four Corners area.

● **Vaughn and Taylor Construction Company, Inc., P. O. Box 3266, Odessa, Texas.** Has

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contract for 48 miles of 8, 6, and 4-in. line between Kermit and Goldsmith, Texas, for *El Paso Natural Gas Company*.

● **Missouri Valley Dredging Company, 1331 South 20th Street, Omaha, Nebraska.** Has 5.6 miles of 24-in. for *Laurel Pipe Line Company* from Eagle Point, New York, to west bank of Delaware River including the river crossing. Also 20 miles of 24-in. from that point to Booth station site in Delaware County, Pennsylvania.

● **Engineers Limited Pipeline Company, 225 Bush Street, San Francisco.** Has 106 miles of 24-in. for *Laurel Pipe Line Company* from Booth station, Delaware County, Pennsylvania, to Mechanicsburg.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 100 miles of 18-in. for *Alberta Gas Trunk Line Company, Ltd.*, from Burstall at the Alberta border to Provost, Alberta. Also has 22 miles of gas gathering line in the Provost field for *Provo Gas Producers, Ltd.*, consisting of constructing gathering system and wellhead tie-ins—3 to 12-in. pipe; this gas to be fed to Alberta Gas Trunk Lines.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Panama Inc., 1418 Melrose Blvd., Houston, Texas.** Has contract for 362 miles of 16-in. for the *Texas-New Mexico Pipeline Company* from Jal, New Mexico, northwestward. Has 193 miles of 4 to 24-in. line in Mocane and Laverne, Oklahoma, fields for *Colorado Interstate Gas Company*. For *Laurel Pipe Line Company*, 78 miles of 20-in. from Mechanicsburg, Pennsylvania, to Duncansville, 118 miles of 18-in. from the latter point to Aliquippa station, Pennsylvania.

● **Morrison-Shivers, Ltd., Box 1076, Austin, Texas.** Has 48 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Nipigon and Beardmore. Also has 62 miles of 30-in. for *Trans-Canada Pipe Lines* at North Bay, Ontario.

How did the Oil Industry Fare in 1957? What's Coming in 1958?

See page A-17

for

Round-Up of Annual Report Statistics

by *Ernestine Adams*

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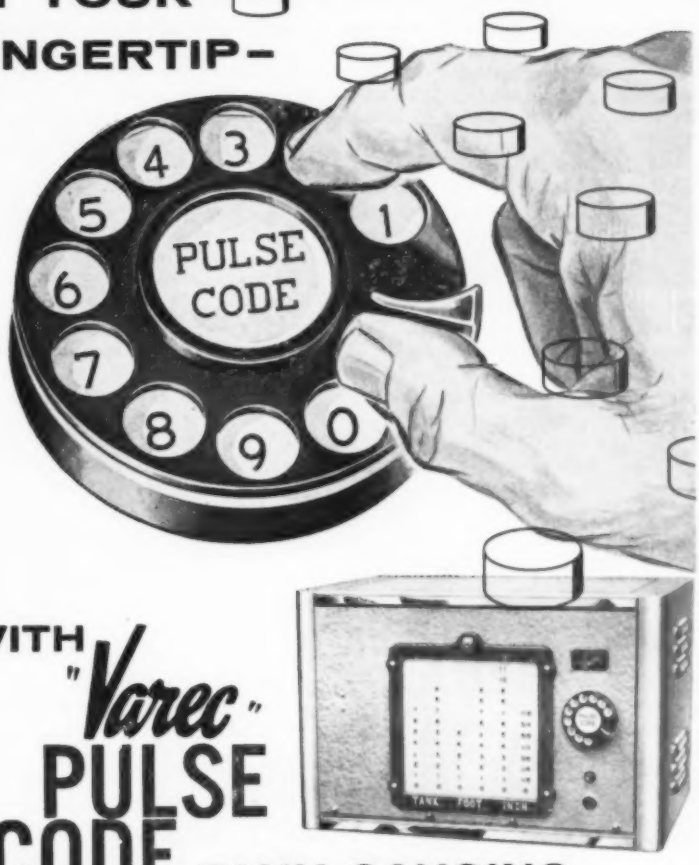

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Pipeline Projects

El Paso Asks More But Gets $138.5 Million OK

The Federal Power Commission has authorized El Paso Natural Gas Company to construct pipeline facilities estimated to cost a total of $138,500,000 to enable it to supply an additional 185,000,000 cu ft of natural gas per day to existing customers in Arizona and California.

The commission acted on two applications, but in one it approved only the facilities necessary to connect new sources of gas supply. This proceeding was remanded to an FPC presiding examiner for decision to determine, among other things, El Paso's ability to supply natural gas for the service proposed in that application.

The first application (Docket G-11,797), which was approved in its entirety, includes the construction of 216 miles of main line, 58,900 hp in compressor capacity, and field facilities consisting of 533 miles of line and 27,850 compressor hp, located in Arizona, Texas, and New Mexico. These facilities, estimated to cost $107,100,000, will be used to supply an additional 75,000,000 cu ft of gas per day jointly to Southern California Gas Company and Southern Counties Gas Company, an additional 75,000,000 cu ft daily to Pacific Gas & Electric Company, and an additional 35,000,000 cu ft per day to existing customers in Arizona, principally in Yuma.

The other application (Docket G-12,580), which was approved only insofar as the field facilities are concerned, involves also the construction of main line facilities to supply up to 100,000,000 cu ft daily to a new customer, Southern California Edison Company, for use in its steam electric power plants in the Los Angeles area. The field facilities authorized by the commission are estimated to cost approximately $31,438,000, out of the total estimated project cost of about $55,502,000. The field facilities include about 266 miles of pipeline, 8920 hp in compressor capacity, and dehydration, metering, and other equipment. The main line facilities involved in this project include 126 miles of pipeline and additional compressor horsepower at new and existing stations.

Southern Natural Files Two Requests Totaling $40 Million

Two applications by Southern Natural Gas Company asking to construct and operate natural gas pipeline facilities in Louisiana costing approximately $40,000,000, have been filed with the Federal Power Commission.

Southern proposes to construct about 136.8 miles of 24 and 26-in. pipeline, about 215.5 miles of various diameter supply lines, 3650 additional compressor hp to its White Castle and Toca stations, about 7.19 miles of 20-in. line loops, 660 additional compressor hp at its Franklinton station, and 23 measuring stations.

The facilities would be extensions and loopings of the company's south Louisiana supply system, designed to increase capacity into the Pickens and Gwinville (Mississippi) station. Southern estimates the increase in capacity at about 298,030,000 cu ft per day.

Proposed facilities would be used to meet current obligations to existing customers. Consolidated with Southern's application were 11 by producers asking authority to sell gas.

Transwestern Start Planned for This Year

Transwestern Pipeline Company on April 15 filed application for a certificate of public convenience and necessity with the Federal Power Commission to authorize Transwestern to build a 1305-mile pipeline transmission system from the natural gas producing areas of West Texas and the Texas-Oklahoma Panhandle to the California-Arizona border.

The $193,000,000 project will enable Transwestern to deliver upon certification and completion of the line an annual daily average of 350,000,000 cu ft of 700-psi pressure gas to its terminal on the Colorado River at Topock, Arizona.

Transwestern's sole customer will be Pacific Lighting Gas Supply Company.

John R. McMillan, Transwestern president, and Mills Cox, executive vice president, stated that the company is hopeful of early certification so that actual construction may begin before year end. It is anticipated, they said, that gas delivery will begin through the vast system by the middle of 1959.

Transwestern, according to McMillan, eventually expects to increase its installed compressor horsepower from 52,000, initially required, to 125,000 hp to accommodate a future demand for 640,000,000 cu ft per day, and Pacific will have the right of first refusal of the added supply.

For the 670 miles of its main line, from Roswell, New Mexico, to Topock, Transwestern will utilize high grade 30-in. diam steel pipe that can withstand higher operating pressures than any of the present gas transmission lines, McMillan said. Weighing 315 tons per mile, the pipe has a yield of 56,000 psi.

Two main 24-in. laterals of the Transwestern system will converge at Roswell.

Six automatically-operated, engine-driven rotary compressor stations will be situated at strategic points along the pipeline to receive gas at 725 psi and boost it with a 1.37 compression ratio to 1000 psi.

NGPL Project Delayed by Memphis Case to Go Ahead

It appears that Natural Gas Pipeline of America will now proceed with a part of the expansion plans that have been held in abeyance as a result of the Memphis Decision. Two things have happened:

1. NGPL has reached agreement with its customers on rate settlements, and has filed new rates with FPC that, if approved, will result in the refunding of more than $10,000,000, plus interest. This will clear up financial uncertainties that have made it difficult to finance expansion.

2. As a consequence, NGPL has filed with the Federal Power Commission an application to construct a 232-mile, 36-in. line between Beatrice, Nebraska, and Joliet, Illinois, and 258 miles of 36-in. and 21 miles of 26-in. between the Texas Panhandle and Beatrice. These facilities would increase capacity by 185,000,000 cu ft a day and would cost approximately $87,000,000. Still pending is an application for NGPL to deliver an additional 485,000,000 cu ft a day.

The project is a revision of an expansion plan approved in April 1957, which included constructing a line from North Texas through southern and southwestern Oklahoma to the Texas Panhandle. This line was put in operation last December.

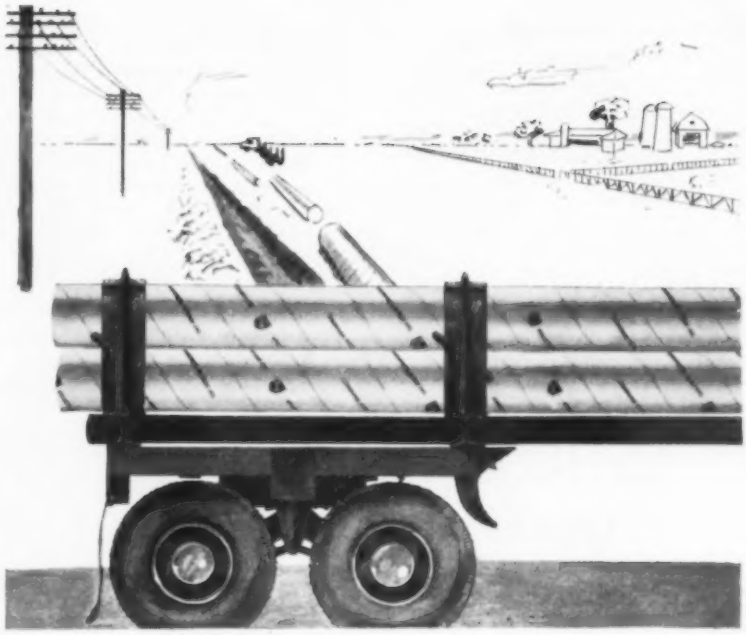
If authorization is granted for the 185,000,000 cu ft project not later than May 1, NGPL will be able to complete the facilities for gas to be available to consumers by January 1, 1959, officials say.

Buckeye to Extend System to Utica

The Buckeye Pipe Line Company announces the extension of its eastern products pipeline system to Utica, New York.

The company's eastern products system began operations in 1953 and extends 371 miles from the refineries and deep water terminals in New Jersey to marketing areas in Pennsylvania and New York. Originating in Linden, New Jersey, and running westward to Macungie (near Allentown, Pennsylvania), thence north into New York State, the line provides transportation for petroleum products to Allentown, Scranton, Wilkes-Barre, Binghamton, Syracuse, Waterloo, Geneva, Rochester, and Buffalo.

Proposed expansion plans call for the construction of 50 miles of 10-in. pipeline from a point just north of Syracuse, New York, to existing shipper terminals at Utica, New York. Work on this line is to start this spring and is scheduled for completion in September.



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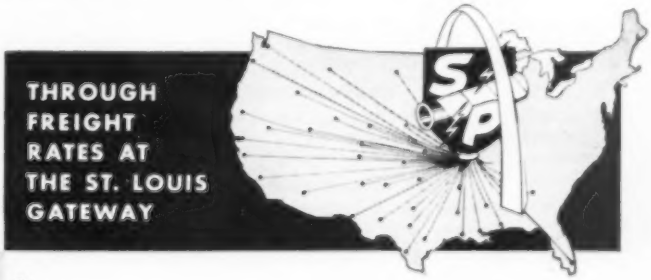

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standard pipeprotection inc.

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FPC Passes Favorably On Four Proposals

The Federal Power Commission has issued orders authorizing the construction and operation of natural gas facilities by four pipeline companies at a combined cost of approximately $6,092,600. The proposals are not related.

Companies receiving the authorizations are: Kentucky Gas Transmission Corporation, Charleston, West Virginia; Gulf Interstate Gas Company, Houston, Texas; The Manufacturers Light and Heat Company, Pittsburgh, Pennsylvania; and Lone Star Gas Company, Dallas, Texas.

Kentucky Gas was authorized (G-13,667) to construct about 20.5 miles of 26-in. transmission line parallel to its existing 20 and 24-in. lines extending from its Foster regulating station in Bracken County, Kentucky, northwesterly to its Cold Springs measuring station in Campbell, Kentucky, opposite Cincinnati, Ohio. The estimated cost of the proposed line is about $2,191,400.

In another order, Gulf Interstate was authorized (G-13,648) to construct approximately $2,000,000 of natural gas facilities during 1958 to enable it to take into its system natural gas that United Fuel Gas Company will purchase from producers in the general area of Gulf Interstate's system for redelivery at Means and Leach, Kentucky. The FPC limited the cost of any individual project constructed under the budget-type authorization to a maximum of $200,000.

Manufacturers, in a third order, was authorized (G-12,155) to construct natural gas facilities at an estimated cost of about $1,160,300, and to abandon certain other facilities, in Ohio and West Virginia. Manufacturers proposes to construct about 21.24 miles of various diameter transmission pipeline; 0.23 of a mile of 16-in. river crossing; and a metering and regulating station to serve Olin Mathieson Chemical Corporation's aluminum plant located near Buck Hill Bottom, Monroe County, Ohio.

The commission authorized Manufacturers to abandon approximately 13.74 miles of small diameter transmission line that will not be required when the proposed lines are in operation. The line will be abandoned in place at an estimated cost of $600.

The FPC's fourth order authorized Lone Star to construct storage facilities in the Ambassador field, Clay County, Texas, a small, partially depleted oil field, presently traversed by Lone Star's pipeline system. Lone Star will construct a compressor station, injection and withdrawal system, and other appurtenant facilities at an estimated cost of about $740,900.

In its application, Lone Star said the working storage capacity will be about 1,566,525,000 cu ft with an injection rate of about 6,000,000 cu ft per day and a withdrawal rate of approximately 50,000,000 cu ft daily, limited by a peak day pipeline capacity of about 24,000,000 cu ft.

Northern Natural Files For New Construction

Northern Natural Gas Company has filed an application with the Federal Power Commission to meet the requests of its presently connected communities for additional supplies of natural gas for the 1958-59 heating season. The new construction would include approximately 57 miles of 30-in. main line loop additions, four miles of 10-in. branch line additions, and compressor additions totaling 8000 hp. Estimated cost of the additional facilities would be about $7,750,000.

An application filed by Northern in January covering service to present customers, as well as new communities, was returned to the company by the commission, which, in effect, stated that certain phases of the 1958 application could not be considered until a decision on the 1957 application, is finally determined.

PLASTIC COATING
HOLIDAY
DETECTOR

ECONOMICAL, HIGHLY PORTABLE, FIELD INSTRUMENT FOR USE IN TAPE COATING HOLIDAY DETECTION

DEPENDABLE, SAFE ON WRAPPINGS
This detector will locate pin-holes and bare spots in plastic tape applications such as polyethylene, etc.

EASILY PORTABLE
Hand-held instrument weighs but 3¾-lb. Easily inspects applications on field joints, service tees, valves and fittings. Not recommended for pipelines.

AUDIO SIGNAL
When the low energy spark locates a perforation through tape wrapping, spark sound is amplified by a speaker inside the unit. Unit has insulated plastic case and handle.

SILICONE-RUBBER ELECTRODES
Pliable silicone-rubber electrode 3½-in. wide can't injure wrappings yet conforms to surface contours, gives accurate check. Other width electrodes avail.

LS-1 DETECTOR COMPLETE CONSISTS OF:
Detector in plastic case with 6-volt, dry-cell battery. Electrode assembly with 3½-in. wide silicone-rubber blade. Ground wire cable 4-ft. long. Carrying case.

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Oklahoma-Missouri Gas Project Is Reorganized

The proposed 500-mile gas line from Oklahoma through Missouri to the St. Louis area has entered a new phase. The Mookl Chemical and Gas Corporation and Missouri Transportation Corporation have been absorbed by a new company known as the Oklahoma-Missouri Gas Transmission Company.

Purchase contracts are now being made and an Oklahoma City engineering firm employed to study gas reserves, according to M. F. Sullivan, president of the transmission company. Application has not yet been made to the Federal Power Commission.

Tentative plans are for a 24-in. system having a capacity of 350,000,000 cu ft a day. It would extend from the Bradley district of Oklahoma northeast through Cleveland, Pottawatomie, Okfuskee, Okmulgee, Muskogee, Wagoner, Cherokee, and Delaware counties, leaving the state at a point just north of Jay. In Missouri the line would serve Rolla and Webster Groves, the latter a surburb of St. Louis.

Oklahoma-Missouri Gas Transmission Company is owned by the Alaska Juneau Gold Mining Company.

New Tie-in Approved For Gathering Company

Application, by Tensas Gas Gathering Corporation, Shreveport, Louisiana, for authority to construct natural gas pipeline facilities in Mississippi and Louisiana, has been approved by the Federal Power Commission.

Tensas proposes to construct and operate approximately 36.61 miles of pipeline, varying from 2 to 8 in. in diameter, extending from the Rodney field in Mississippi westerly across the Mississippi River to a connection with an existing pipeline in Tensas Parish owned by Olin Gas Transmission Company, Monroe, Louisiana. Tensas also proposes to build three compressor stations and field boosters having a total of 2000 hp in the North Locust Ridge field, South Locust Ridge field, and Lake St. John field, in Tensas and Concordia parishes, Louisiana. Cost of the proposed project is about $855,400.

Olin has filed an application seeking authority to construct a line tap and measuring station to purchase and receive natural gas from Tensas (G-13, 589). Olin also filed an application (G-13,666) seeking authority to construct about 4.7 miles of 8-in. line to enable it to sell up to 10,000 cu ft per day to Crown Zellerbach Corporation for use as fuel in the proposed St. Francisville Paper Company mill. The cost of the two proposals is approximately $190,550.

Maloney

SCRAPER CUPS

SETTING NEW STANDARDS FOR THE INDUSTRY

MALONEY SCRAPER CUPS have long set the Standard for the Industry. Now a new improved Maloney Cup is setting New standards. Available immediately from stock in a full range of sizes from two inch through 36 inch.

The New design is tough, long wearing, and flexible. Out-of-round or varying weight pipe can be accommodated with equal ease, and the design assures full sealing area throughout the full life of the cup.

Ideal for on-stream pigging, clean-out service, hydrostatic testing, water or product removal, etc., the Scraper Cups are designed, compounded and molded entirely by the Maloney Company. Scraper Discs are also available manufactured with the same standards in sizes from four through twenty inches.

NEW DESIGN

A USER'S REPORT ON MALONEY SCRAPER CUPS . . .

". . . The cups, as redesigned, are doing an extremely good "wiping job" reducing squeegee runs required after hydrostatic testing to a minimum. The wearing quality of the cups seems to be very good.

As final "proof of the pudding," we have not had any dewpoint problems after placing lines constructed and hydrostatically tested in service during this year's construction . . ."

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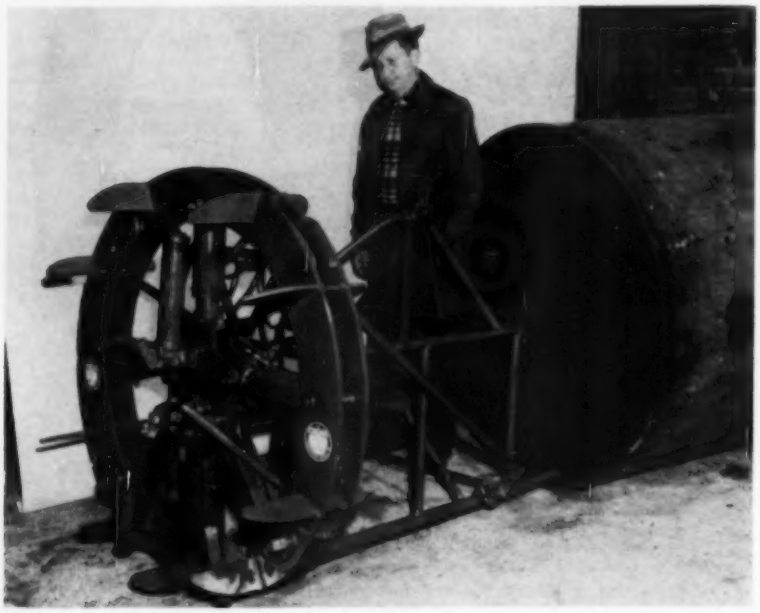
NEW Pipeline Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers



M. J. Crose Manufacturing Company announces this is the largest internal hydraulic line-up clamp built to date.

Internal Hydraulic Line-up

This clamp was recently built to handle 55-in. pipe such as shown in this photo. Average size man, inspecting this new Crose product, helps to show the giant-size dimensions of this clamp and its heavy construction.

Crose designed and built it for special pipeline project, but makes smaller hydraulic type clamps for more conventional sizes of pipe. *M. J. Crose Manufacturing Company.*

Circle number (81) on reply card.

Building Block Switches

A new series of modular-mount lighted pushbutton switches—designed for easy mounting and uniform, modern appearance — has been introduced by Micro Switch. Switch assemblies are available in 3 models—a light-force, a positive touch-feedback and an alternate-action design. Two-, three- and four-pole switching assemblies are available in the light-force and positive touch-feedback designs. Two-pole double-throw circuitry is provided in the alternate-action switch.

The switches (known as Series 100PB), which bring new styling and ease of installation to panels, mount end-to-end in rectangular slots. *Micro Switch, a division of Minneapolis-Honeywell Regulator Company.*

Circle number (82) on reply card.

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It's *The Petroleum Engineer*, read and relied upon by operating men throughout the U. S. and sixty-seven foreign countries. The specialized editions of Drilling and Producing, Refining and Petrochemical, Oil and Gas Pipelining and the Management Edition's all-industry coverage are prepared especially for operating men.

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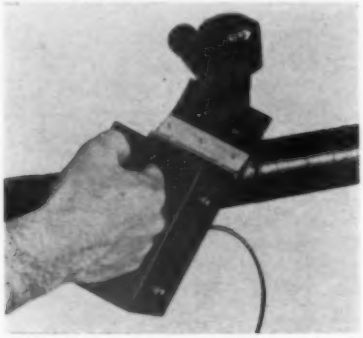
New Equipment

Holiday Detector for Plastic Tape

A new lightweight, economical Holiday detector for testing the continuity of plastic tape applications is being offered. Designated as their Model LS-1 this detector was developed particularly for the electrical inspection of plastic tapes when such material is used for wrapping field joints, service tees, risers, and similar coating applications.



The detector operates from a simple lantern type, dry cell battery through a detachable fiberglass reinforced, electrically conductive, silicone rubber electrode. The unit is housed in a strong, moulded plastic case with plastic handle. Holidays, breaks, or weak spots in the wrapping are signalled by an audio system. *Tinker & Rasor.*

Circle number (83) on reply card.

Fresh Water Still

A new portable water still that produces drinking water without operating expense has been announced by Engineering Controls. The stills are custom designed for each installation. Capacity of the still depends primarily on the user's requirements; as much as several hundred gallons of clear, fresh drinking water can be produced each hour. *Engineering Controls, Inc.*

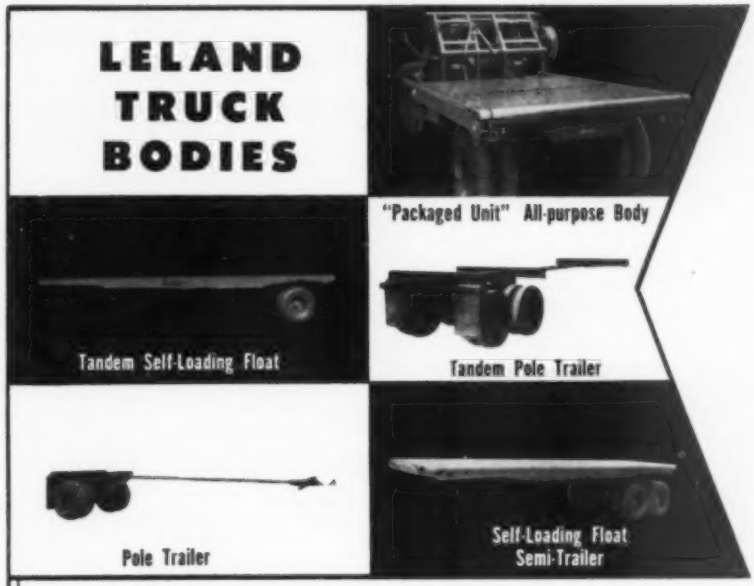
Circle number (84) on reply card.

High-Speed Synchronous Generator

Redesign of its high-speed synchronous generators in single bearing units for internal combustion engines, close-coupled to standard SAE flanges, or in 2-bearing units for belt drives or direct connection has been announced by Allis-Chalmers.

Available in ratings from 30 through 150 kw at 1800 rpm and 50 through 300 kw at 1200 rpm, the high-speed synchronous generators feature an improved exciter located inboard of the bearing to provide a shorter, lighter, more compact machine. *Allis-Chalmers Mfg. Company.*

Circle number (85) on reply card.



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In the race to beat cost on construction and maintenance, Leland continues to lead the trucking industry in dependability, performance, durability and safety.

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New Equipment

New Stationary Compressor

The 25S2, a 25-hp model, has been announced by the Le Roi Division. It completes Le Roi's line of compressors from ½ to 100 hp. The small, compact unit is rated for continuous duty at 175 psi. It fills the needs for a high volume, high pressure air compressor. *Le Roi Division, Westinghouse Air Brake Company.*

Circle number (86) on reply card.

New 100-Watt Unit

General Electric announces their first thermostatically-protected transistor-powered 100-w mobile radio. The equipment is designed with automatic cut-off and reset functions which keep the transistor power supply safe against abuse due to heat caused by overload, duty cycle and environmental conditions. *General Electric Company.*

Circle number (87) on reply card.

Easyarc Stainless Electrodes

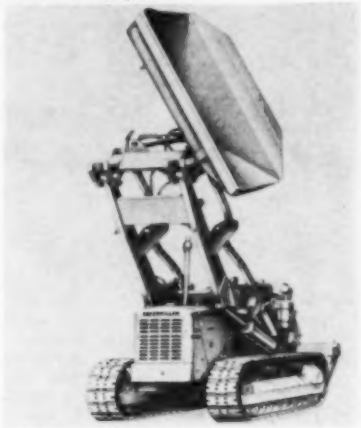
Three new stainless steel electrodes, designated as Easyarc 308, 316, and 347, are available. They are the first powdered metal stainless electrodes ever offered.

These ac-dc electrodes have a coating which contains chromium and nickle in powdered form, accurately measured and proportioned to meet metallurgical standards, and will deposit homogeneous weld metal easily and more economically than heretofore possible. *Air Reduction Sales Company, a division of Air Reduction Company, Inc.*

Circle number (88) on reply card.

Side Dump Attachment

The side dump bucket, which has shown its strength and versatility on the Caterpillar No. 955 and 933 traxcavators, has been made available for the company's largest model traxcavator, the No. 977. In announcing the availability of the new 2¼ cu yd capacity side dump attachment, Caterpillar noted that job reports have shown the tool especially useful for stockpile loading, trench or basement backfilling, excavation of broken or loose material, etc.



The benefits of in-line loading are now afforded to the No. 977, including the ability to load without the continual turning demanded of standard tractor-shovels. The reduction in turning leads to higher production through lower cycle time, and lower maintenance due to decreased wear on track parts. The reduction of ground scuffing, a desirable feature on many traxcavator applications, is also provided by use of the side dump bucker. *Caterpillar Tractor Company.*

Circle number (89) on reply card.

Sequence Controller

SIE's new compressor start unit (CSU-1) sequences all yard, compressor and auxiliary valves automatically. The unit will start and bring on line a compressor on receipt of a single actuating signal. It therefore permits highly efficient semi-automatic operation of a compressor station from the control room.

Addition of the SIE compressor station computer controller and SIE telemetering transceivers provides a truly modern system approaching the fully automatic pipe line. *Southwestern Industrial Electronics Company.*

Circle number (90) on reply card.

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New Equipment

Base Station Multiplies Area Coverage

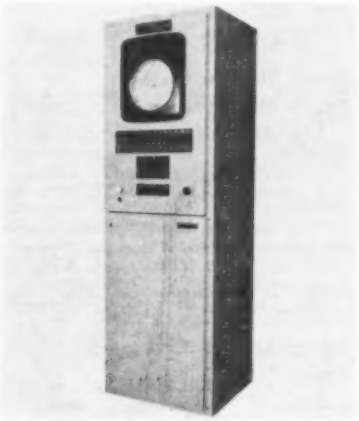
A new radio base station announced by Motorola incorporates a 250-w transmitter and a highly sensitive receiver to extend range of 2-way mobile radio systems operating in the 450-460 megacycle band.

The high power transmitter of the equipment, used with a high gain antenna, provides effective radiated power of more than 2 kw. This will normally double the range and so quadruple the area covered by the low power transmitters presently available for use in this band. Up to now, the range necessary for larger UHF systems could be obtained only through use of excessive antenna tower height or multiple base stations. *Motorola, Inc.*

Circle number (91) on reply card.

Supervisory Control System

A new industrial system that provides up to 104 channels of control supervision over 1 transmission circuit has been marketed. The supervisory control system has been developed for controlling and monitoring far-flung continuous process operations where economical use of transmission mediums is mandatory.



The system has particular application in power and water distribution systems, oil fields and pipeline systems. Well-established coding and decoding techniques, accomplished by dependable telephone-type relays, enable the system to perform equally well on a variety of transmission mediums. *Applied Science Corporation of Princeton.*

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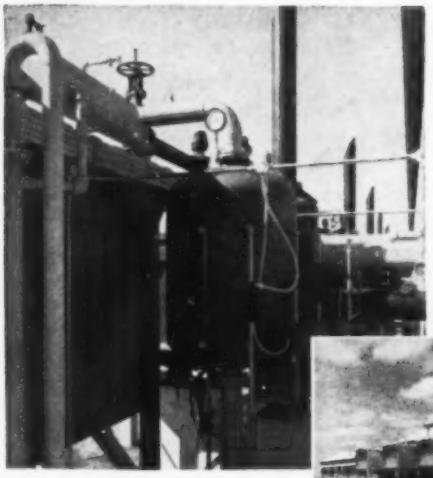
UNITED GAS PIPE LINE CONVERTS TO VAPOR PHASE®



Eliminates Engine Power for Driving Turbine Fan . . . Utilizes Power Cylinder Waste Heat

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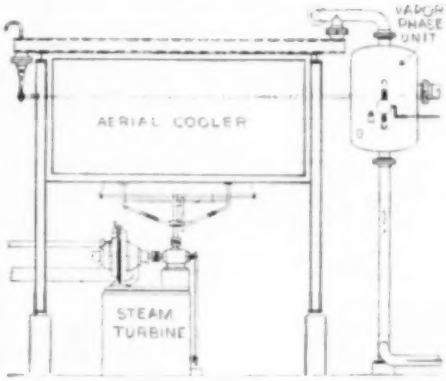

During September, 1956, one fan-drive was converted to the Vapor Phase Steam Turbine Fan Drive (utilizing power cylinder waste heat as steam at 15 p.s.i.g. pressure), thus eliminating engine power formerly required to drive the fan for lube oil cooling and steam condensing.

"Sole Developers and Manufacturers of Vapor Phase Thermal Circulation (Ebullition) Engine Cooling"

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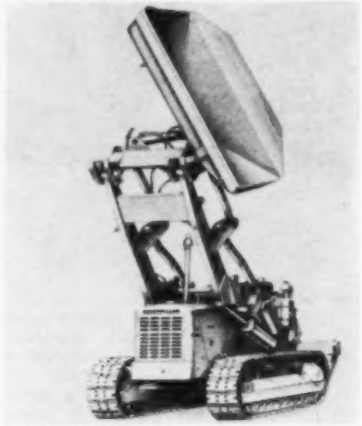

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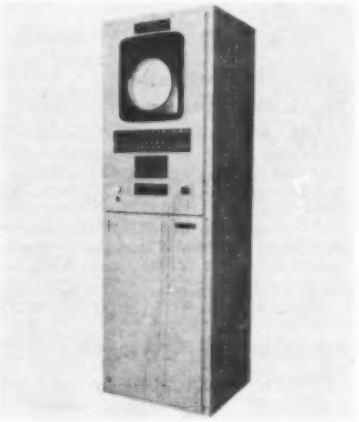

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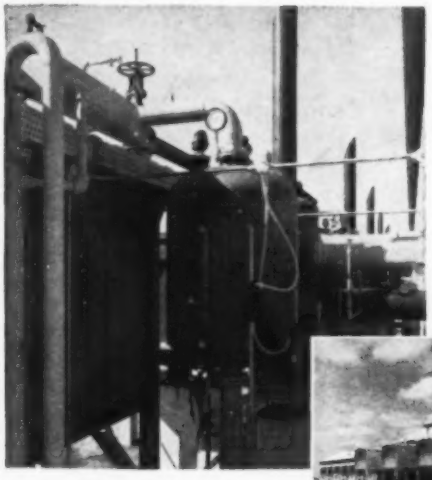

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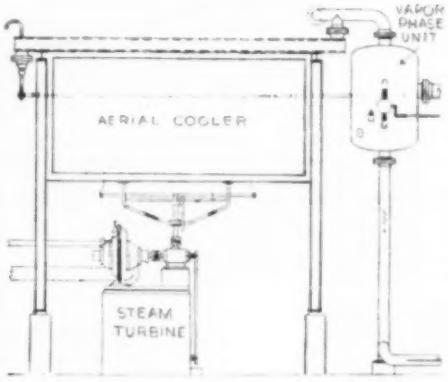

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D-89

NEW LITERATURE

Diesel Crawler Tractors and Power Units

Tips on saving time and money in oil field work are contained in a new 12-page booklet released by International Harvester. The booklet, describes the use of diesel crawler tractors and power units of various sizes and is profusely illustrated with on-the-job pictures. *International Harvester Company.*

Circle number (93) on reply card.

Aluminized Steel Type 2

A new manual from Armco Steel gives detailed information on aluminized (aluminum-coated) steel Type 2. Some of the subjects covered are atmospheric corrosion resistance, mechanical properties of the steel base, resistance to fire damage, and high heat reflectivity. The booklet contains sections on available sizes, gages and forms, fabricating and finishing and storing and handling. *Armco Drainage & Metal Products, Inc.*

Circle number (94) on reply card.

Centrifugal Catalog

This 64-page, illustrated catalog includes an introduction to centrifugal compressor features and applications; sections on horizontally and vertically split compressors; and a general section dealing with compressor fundamentals, parts, drivers, engineering data and specifications. *Clark Bros. Company.*

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PELICAN SUPPLY CO. INC.

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SEE YOUR NEAREST SUPPLY HOUSE

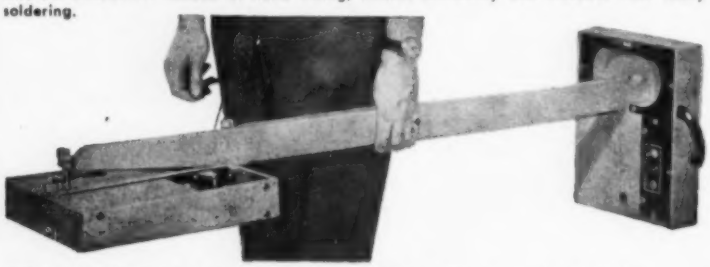
(Formerly: Pelican Well Tool & Supply Company)

The WILKINSON LINE LOCATOR

PREVENTS COSTLY DAMAGE

Spots all sub surface pipes, cables, etc., and determines their depth accurately.

ETCHED CIRCUITRY: instead of hand wiring, insures uniformity and freedom from faulty soldering.



BATTERY TESTER: instantly indicates battery condition without removing batteries.

INSTRUMENT CASE: Made of tough, wear resisting phenolic material. The antennas are an integral part of cases, moisture and shock proof.

WILKINSON PRODUCTS COMPANY

3987 Chevy Chase Drive, PASADENA 3, CALIFORNIA. SYlvan 0-4314

New Busway

General Electric's new 225-1000 amp plug-in Flex-A-Power busway with aluminum conductors is the subject of a 24-page book. Known as the Type DE, the busway is available in both 3- and 4-pole construction for 3-wire, 3-phase, or 4-wire, 3-phase applications. It has a 50,000 amp RMS asymmetrical short circuit bracing as standard. *General Electric Company.*

Circle number (96) on reply card.

95-Ton Crane, 3 Cu Yd Shovel

A 24-page catalog released by Koehring Division contains 11 on-the-job and 46 assembly photos of the Koehring 1205 excavator. Printed in 2 colors, the catalog has a special section devoted to the 1205 carbody and lower machinery. Included in the section are an explanation and photos of the 6 turntable and 6 hook rollers used to maintain operating stability under any digging or lifting strain. Schematic drawings trace the power flow through the turntable and carbody. *Koehring Division.*

Circle number (97) on reply card.

Wagon Drill Flier

Ingersoll-Rand's new flier, Form 4191, describes the company's 3 models of wagon drills—the FM-4 wagon drill, the FM-4 rotary and the lightweight JHM "wagonjack" mounting. The manufacturer describes the FM-4 wagon drill as the "workhorse" of the three. It is a percussion drill designed for tough, sustained work on road building, general construction, foundation and quarry jobs. *Ingersoll-Rand.*

Circle number (98) on reply card.

Rock Bit Bulletin

A new 6-page bulletin describing its line of 1-use drill bits has been published by the Le Roi Division. The new RD29 bulletin illustrates bit construction, preparation of drill rod shanks, and lists specifications. Drawings and photographs are used to illustrate the offset gage, thinner wings, and steeper reamer angle of the CRD 1-use bits. *Le Roi Division, Westinghouse Air Brake Company.*

Circle number (99) on reply card.

New Thermalastic Insulation Booklet

A 12-page booklet, "Thermalastic®—The Insulation System" for large motors and generators, synchronous condensers and frequency changers, is available. The advantages of Thermalastic insulation, that extend the life of heavy rotating equipment in hard service, are presented. Laboratory test charts are discussed. *Westinghouse Electric Corporation.*

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Inhibitor for Corrosion Prevention

Oakite PC 5, the organic, amine type inhibitor designed for injection into the product stream, is described in a service report available from Oakite Products. The report tells how the use of Oakite PC 5 can reduce metal replacement costs, reduce downtime, increase throughput, and step up heat exchange efficiency in such units as accumulators, overhead condensers, fractionating towers, etc. *Oakite Products, Inc.*

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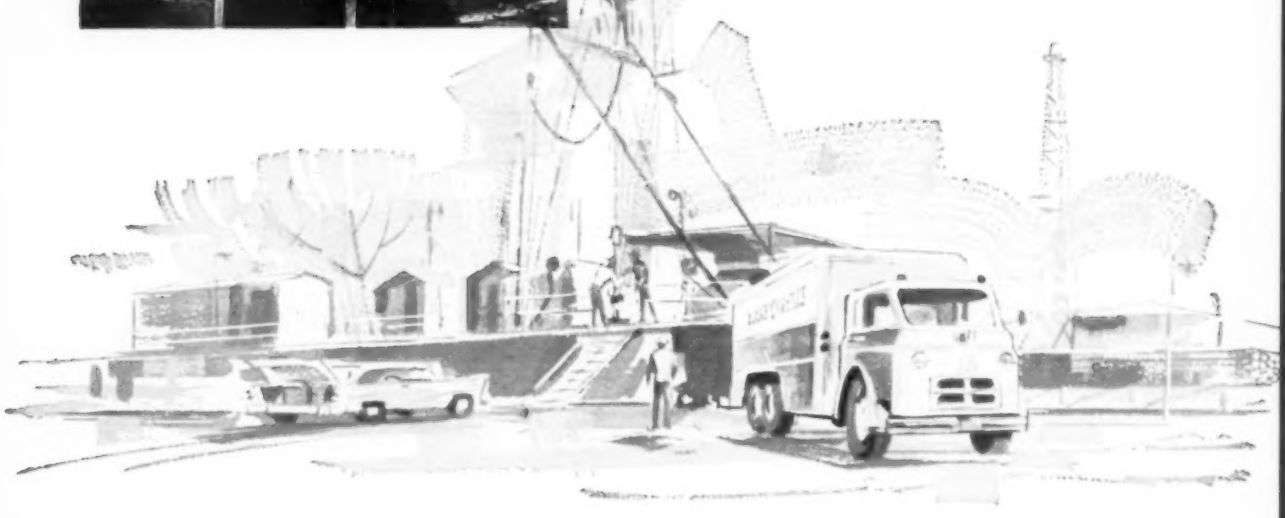
LANE-WELLS

VIBRO-FRAC

SERVICE MEANS

more Oil for YOU!



- 2 BOD increased to 24 BOD
- 0 BOD increased to 18 BOD
- 0 BOD increased to 10 BOD
- 700% increase in production

These results are typical of the increases in production obtained in well after well by using Vibro-frac, Lane-Wells' new explosive fracturing service.

Vibro-frac is a wire line service for selectively fracturing formations. High frequency pressure oscillations or shock waves, initiated by special explosives, produce the fracturing effect. These effects are selectively controlled by special methods of perforating.

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